

HANFORD SITE



Summary of the Hanford Site Environmental Report

for Calendar Year 2002

SUMMARY OF THE HANFORD SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2002



EDITORS

R. W. HANF

L.F. MORASCH

G.P. O'CONNOR

T.M. POSTON

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PACIFIC NORTHWEST NATIONAL LABORATORY
RICHLAND, WASHINGTON 99352



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REPORT INQUIRIES

Inquiries about this booklet or comments and suggestions about its content may be directed to Mr. D. C. (Dana) Ward, Department of Energy, Richland Operations Office, Closure Division, P.O. Box 550, Richland, Washington 99352 (Dana_C_Ward@apimc01.rl.gov) or to Mr. T. M. (Ted) Poston, K6-75, Pacific Northwest National Laboratory, P.O. Box 999, Richland, Washington 99352 (ted.poston@pnl.gov).

Copies of this summary booklet and the 2002 report have been provided to many public libraries in communities around the Hanford Site and to several university libraries in Washington and Oregon. Copies also can be found at DOE's Public Reading Room located in the Consolidated Information Center, Room 101L in Richland, Washington. Copies of the 2002 report can be obtained from Mr. R. W. (Bill) Hanf, K6-75, Pacific Northwest National Laboratory, P.O. Box 999, Richland, Washington 99352 (bill.hanf@pnl.gov) while supplies last. The reports can be accessed on the Internet at <http://hanford-site.pnl.gov/envreport>.

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The Columbia River flows eastward through the northern part of the Hanford Site and then turns south, forming part of the eastern site boundary, shown above.

INTRODUCTION

The Hanford Site Environmental Report, published annually since 1958, includes information and summary data that provide an overview of the activities at the Hanford Site; demonstrate the status of the site's compliance with applicable federal, state, and local environmental laws and regulations, executive orders, and U.S. Department of Energy (DOE) policies; summarize environmental data that characterize Hanford Site environmental management performance; and highlight significant programs.

This booklet summarizes the Hanford Site Environmental Report for Calendar Year 2002. This booklet briefly describes (1) the Hanford Site and its mission; (2) environmental programs at the Hanford Site; (3) estimated radionuclide exposures to the public from 2002 Hanford Site activities; (4) the status of the site's compliance with environmental regulations; and (5) information on environmental monitoring and surveillance programs and activities. Readers interested in more detailed information can consult the 2002 report or the technical documents cited and listed in that report.



The Hanford Site contains a biologically diverse plant community that has been protected from disturbance over the past 55 years.

OVERVIEW

OF THE HANFORD SITE AND ITS MISSION

The Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State. The site occupies an area of ~586 square miles located north of the city of Richland. A plutonium production complex with nine nuclear reactors and associated processing facilities, the Hanford Site played a pivotal role in the nation's defense for more than 40 years, beginning in the 1940s with the Manhattan Project. Today, under the direction of the DOE, Hanford is engaged in the world's largest environmental cleanup project.

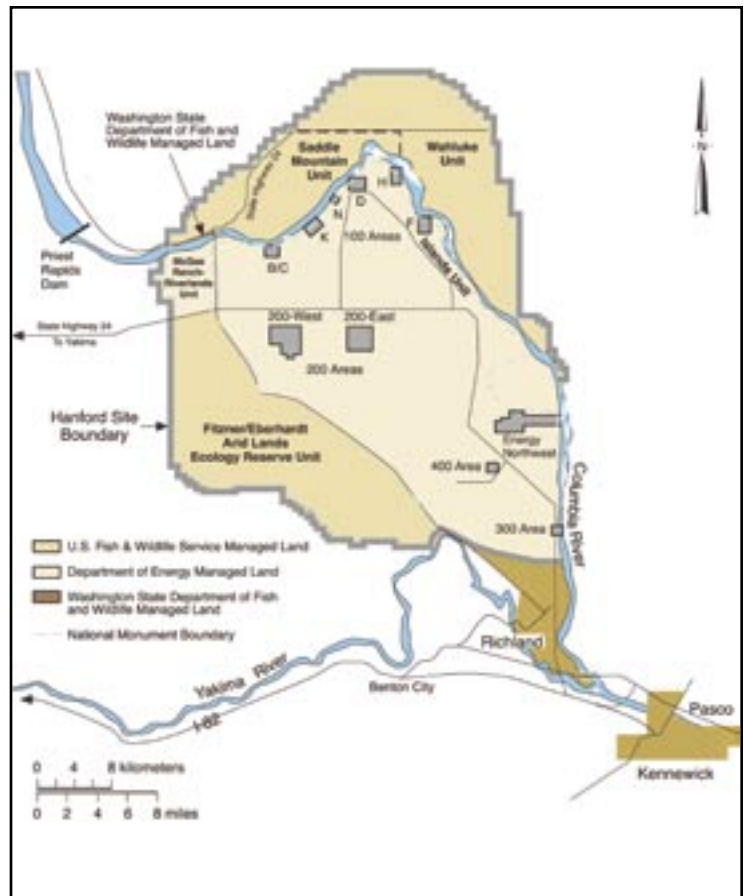
This large area has restricted public access and provides a buffer for the smaller areas on the site that historically were used for production of nuclear materials, waste storage, and waste disposal. The Columbia River flows eastward through the northern part of the Hanford Site and then turns south, forming part of the eastern site boundary.

In June 2000, the 195,000-acre Hanford Reach National Monument was established by a Presidential Proclamation to protect the nation's only non-impounded stretch of the Columbia River above Bonneville Dam and the largest remnant of the shrub-steppe ecosystem once blanketing the Columbia River Basin.

In 2002, DOE, the U.S. Fish and Wildlife Service, and the Washington Department of Fish and Wildlife were joint stewards of the monument. The U.S. Fish and Wildlife Service administering three major management units of the monument totaling ~165,000 acres. These included (1) the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit, a 120-square-mile tract of land in the southwestern portion of the Hanford Site; (2) the Saddle Mountain Unit, a 50-square-mile tract of land located north-north-west of the Columbia River and generally south and east of State Highway 24; and (3) the Wahluke Unit, a 87-square-mile tract of land located north and east of both the Columbia River and the Saddle Mountain Unit.

The portion of the monument administered only by DOE included the McGee Ranch/Riverlands Unit (north and west of State Highway 24 and south of the Columbia River), the Columbia River islands in Benton County, the Columbia River corridor (one-quarter mile inland from the Hanford Reach shoreline) on the Hanford (Benton County) side of the river, and the sand dunes area located along the Hanford side of the Columbia River north of Energy Northwest.

Approximately 400 acres along the north side of the Columbia River, west of the Vernita Bridge, and south of State Highway 243 is managed by the Washington Department of Fish and Wildlife. All these lands have served as a safety and security buffer zone for Hanford Site operations since 1943, resulting in an ecosystem that has been relatively untouched for nearly 60 years.



This map shows management units on the Hanford Reach National Monument and the operational areas of the Hanford Site.



The ferruginous hawk, which is found on the Hanford Site, is a federal species of concern and state-listed threatened species.



Canada goose nesting surveys have been conducted at the Hanford Site since the 1950s.



Lizards are one of 17 species of reptiles and amphibians found on the Hanford Site.

SITE DESCRIPTION

The Hanford Site contains a biologically diverse shrub-steppe plant community that has been protected from disturbance, except for fire, over the past 55 years. This protection has allowed plant species and communities that have been displaced by agriculture and development in other parts of the Columbia Basin to thrive at Hanford.

More than 100 rare plant populations of 31 different taxa are found on the Hanford Site. The U.S. Fish and Wildlife Service has designated 5 of these 31 taxa as species of concern in the Columbia River Basin ecoregion. Two species (Umtanum buckwheat and White Bluffs bladderpod) are proposed as candidates for federal listing.

More than 1,000 species of insects, 17 species of reptiles and amphibians, 44 species of fish, 258 species of birds, and 42 species of mammals have been found on the Hanford Site. Deer and elk are the major large mammals. A herd of Rocky Mountain elk has inhabited the site since 1972. Coyotes also are plentiful on the site, and waterfowl are numerous on the Columbia River. The Great Basin pocket mouse is the most abundant mammal on the site.

There are two types of natural aquatic habitats on the Hanford Site. One is the Columbia River and associated wetlands, and the second is upland aquatic sites. The upland sites include small springs, streams, and seeps located mainly on the Fitzner/Eberhardt Arid Lands Ecology Reserve on or near Rattlesnake Mountain (e.g., Rattlesnake Springs, Dry Creek, Snively Springs) and West Lake, a small, natural pond near the 200 Areas.

Salmon and steelhead are the fish species of most interest to sport fishermen and are commonly consumed by local Native American tribes. Fall chinook salmon spawn in the Hanford Reach of the Columbia River, the most important natural spawning area in the main-stem Columbia River. Surveys of the Hanford Reach during 2002 detected ~8,040 redds (salmon spawning nests); this is an increase of nearly 1,800 from 2001 and is similar to numbers seen during the late 1980s.

During 2002, an examination of Canada goose nesting surveys revealed that excluding the public from portions of the Hanford Site has allowed geese to thrive. This observation is supported by increases in the number of nests and hatching rates of geese.

HANFORD AT A GLANCE

| | |
|--------------------------|---|
| Location | The U.S. Department of Energy's Hanford Site is located in southeastern Washington State near the city of Richland. |
| Dominant Feature | Rattlesnake Mountain on the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve rises 1,074 meters (3,525 feet) above sea level. |
| Size | The site covers approximately 1,517 square kilometers (586 square miles). |
| Employees | DOE and its contractors employ ~11,000 workers annually. |
| Mission | Hanford's mission is to safely clean up and manage the site's legacy wastes and reduce the size of the site. |
| Budget | The fiscal year 2003 budget was approximately \$2.6 billion. |
| Site Management | DOE Richland Operations Office and DOE Office of River Protection |
| Prime Contractors | Fluor Hanford, Inc. (nuclear legacy cleanup), Battelle Memorial Institute operates Pacific Northwest National Laboratory (research and development), Bechtel Hanford, Inc. (environmental restoration), Hanford Environmental Health Foundation (occupational and environmental health services), CH2M HILL Hanford Group, Inc. (storing and retrieving waste stored in 177 underground tanks), Bechtel National, Inc. (design, build, and commission a waste treatment plant to vitrify Hanford's tank waste), and S.M. Stoller Corporation (vadose zone). |

Several species of mammals, birds, mollusks, reptiles, and invertebrates occurring on the site are candidates for formal listing under the *Endangered Species Act of 1973*. The U.S. Fish and Wildlife Service lists the bald eagle as threatened. The bald eagle is a winter resident at Hanford and has initiated nesting on the site but has never successfully produced offspring.

OPERATIONAL AREAS

The major DOE operational, administrative, and research areas on and around the Hanford Site include:

- The 100 Areas are located on the south shore of the Columbia River. These are the sites of nine retired plutonium production reactors (100-B, 100-C, 100-D, 100-DR, 100-F, 100-H, 100-KW, 100-KE, 100-N) that occupy ~4 square miles.
- The 200-West and 200-East Areas are located on a plateau and are ~5 and 7 miles south and west of the Columbia River. The 200 Areas cover 6.2 square miles.
- The 300 Area is located just north of Richland. This area covers ~0.6 square mile.
- The 400 Area is located ~5 miles northwest of the 300 Area. This area covers ~0.23 square mile.
- The 600 Area includes all of the Hanford Site not occupied by the 100, 200, 300, and 400 Areas.
- The former 768-acre 1100 Area is located between the 300 Area and the city of Richland. This area was transferred to the Port of Benton in 1998 as part of DOE's Richland Operations Office economic diversification efforts and is no longer part of the site. DOE contractors continue to lease facilities in this area.
- The Richland North Area (off the site) includes the Environmental Molecular Sciences Laboratory and other DOE and contractor facilities, mostly leased office buildings, generally located in the northern part of the city of Richland.



More than 258 species of birds have been found on the Hanford Site.



The Hanford Site has provided protection for plant communities that have been displaced by agriculture and development in other parts of the Columbia Basin.

CURRENT MISSION

For more than 40 years, Hanford Site facilities were dedicated primarily to the production of plutonium for national defense and management of the resulting waste. Hanford was the first plutonium production site in the world. In recent years, efforts at the site have focused on developing new waste treatment and disposal technologies and characterizing and cleaning up contamination left from historical operations.

Currently, the Hanford Site's primary mission includes cleaning up and shrinking the size of the site from ~586 square miles to ~75 square miles by the target date of 2012. *Accelerating Cleanup and Shrinking the Site* states that the cleanup mission includes three strategies:

- restoring the Columbia River corridor by continuing to clean up Hanford Site sources of radiological and chemical contamination that threaten the air, groundwater, or Columbia River. It is expected that most river corridor projects will be completed by 2012.
- transitioning the Central Plateau (200-East and 200-West Areas) from primarily inactive waste storage to active waste characterization, treatment, storage, and disposal operations which are expected to last for another 40 years.

- preparing for the future by getting ready for long-term stewardship, other DOE and non-DOE federal missions, and other public and private sector uses.

The goal of these strategies is to complete major portions of the site cleanup by 2012 and to do so in a manner that protects the environment and uses taxpayer's dollars wisely and efficiently.

The DOE Richland Operations Office and the DOE Office of River Protection jointly manage the Hanford Site through several contractors and their subcontractors. The DOE Richland Operations Office manages legacy cleanup, research, and other programs at the Hanford Site. The DOE Office of River Protection was established by Congress in 1998 as a field office to manage DOE's largest, most complex environmental cleanup project – Hanford's tank waste retrieval, treatment, and disposal.



Canada geese are often seen on the Columbia River along the Hanford Reach National Monument.

COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

It is the policy of DOE that all activities be carried out in compliance with applicable federal, state, and local environmental laws and regulations, DOE Orders, Secretary of Energy Notices, DOE Headquarters and site operations office directives, policies, and guidance. This includes those specific requirements, actions, plans, and schedules identified in the Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement) and other compliance or consent agreements.

Both the DOE Richland Operations Office and the DOE Office of River Protection recognize the importance of maintaining a program of self-assessment and regulatory reporting to assure that environmental compliance is achieved and maintained at the Hanford Site.

The table on the following page summarizes DOE's compliance with federal acts in 2002. Performance related to the Hanford Federal Facility Agreement and Consent Order is described in the following subsection.

COMPLIANCE WITH FEDERAL ACTS AT THE HANFORD SITE IN 2002

| REGULATION | WHAT IT COVERS | 2002 STATUS |
|---|---|---|
| Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) | Sites already contaminated by hazardous materials. | Work on these sites followed CERCLA requirements and met the schedules established by the Tri-Party Agreement. |
| Emergency Planning and Community Right-to-Know Act | The public's right to information about hazardous chemicals in the community and emergency planning procedures. | The Hanford Site met the reporting requirements contained in this act in 2002. |
| Resource Conservation and Recovery Act (RCRA) | Hazardous waste being generated, transported, stored, treated, or disposed. | The Washington State Department of Ecology identified two non-compliance issues during 2002. One was the leak detection system used with the temporary waste transfer lines at the single-shell tank farms. The other was the 600 Area Purgewater, Storage, and Treatment Facility. The letter citing this concern was later rescinded. |
| Clean Air Act | Air quality, including emissions from facilities and diffuse and unmonitored sources. | According to the Washington State Department of Health, air emissions from Hanford Site facilities were well below state and federal standards. However, the Washington State Department of Health issued one non-compliance order regarding notification requirements in 2002. Corrective efforts were completed. |
| Clean Water Act | Discharges to U.S. waters. | The site had two National Pollutant Discharge Elimination System Permits and seven State Wastewater Discharge Permits in 2002. |
| Safe Drinking Water Act | Drinking water supplies operated by DOE. | There were nine public water systems on the Hanford Site. The systems were monitored, and all analytical results for 2002 met the requirements of the Washington State Department of Health. |
| Toxic Substances Control Act | Primarily chemicals called polychlorinated biphenyls. | Five hundred ninety-three drums of depleted uranium in oil containing polychlorinated biphenyls were removed from the 300 Area to the Environmental Restoration Disposal Facility staging area where they will remain pending treatment and disposal. |
| Federal Insecticide, Fungicide, and Rodenticide Act | Storage and use of pesticides. | At the Hanford Site, pesticides are applied by licensed commercial pesticide operators. |
| Endangered Species Act of 1973 | Rare species of plants and animals. | Hanford activities followed the requirements of this act. The Hanford Site has eleven plant species, two fish species, and six bird species on federal or state lists of threatened or endangered species. |
| American Indian Religious Freedom Act, Antiquities Act, Archaeological and Historic Preservation Act, Archaeological Resources Protection Act of 1979, Historic Sites Buildings and Antiquities Act, National Historic Preservation Act, and Native American Graves Protection and Repatriation Act | Cultural resources. | One hundred sixty-four cultural resource reviews were conducted on the Hanford Site in 2002. |
| National Environmental Policy Act | Environmental impact statements for federal projects. | Environmental impact statements and environmental assessments were prepared or conducted as needed. In 2002, there were 20 site-wide categorical exclusions. |
| Migratory Bird Treaty Act | Migratory birds or their feathers, eggs, or nests. | Hanford activities used the ecological review process as needed to minimize any adverse effects to migratory birds. Over 100 species of birds that occur on the Hanford Site are protected by this act. |

HANFORD FEDERAL FACILITY AGREEMENT AND CONSENT ORDER

A key element in Hanford's compliance program is the Tri-Party Agreement. The Tri-Party Agreement is an agreement among the EPA, Washington State Department of Ecology, and DOE to achieve compliance with the remedial action provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) and with treatment, storage, and disposal unit regulation and corrective action provisions of the *Resource Conservation and Recovery Act* (RCRA).

The Tri-Party Agreement (1) defines the RCRA and the CERCLA cleanup commitments, (2) establishes responsibilities, (3) provides a basis for budgeting, and (4) reflects a concerted goal to achieve regulatory compliance and remediation with enforceable milestones in an aggressive manner. Also, the Tri-Party Agreement contains requirements for how to involve the public with Hanford Site decisions.

The Tri-Party Agreement has continued to evolve as site cleanup progresses. Significant changes to the agreement have been negotiated to meet changing conditions and cleanup needs. All significant changes to the agreement undergo a process of public involvement that assures communication and addresses the public's values prior to final approvals.

In 2002, there were 40 specific cleanup milestones scheduled for completion: 36 were completed on or before their required due dates, 2 were completed beyond their established due dates, and 2 are yet to be



Some Tri-Party Agreement milestones completed in 2002 were related to work on Hanford tanks.

completed. The two milestones that were completed after their due date were M-034018A (removed 1,053 tons of spent nuclear fuel from the 100-K-West Basin and transported them to the Cold Vacuum Drying Facility) and M-034-29 (completed 100-K-East and 100-K-West Basin facility modifications for an alternate fuel transfer strategy). The two milestones that are yet to be completed are M-034-08 (begin full-scale sludge removal at the 100-K-East Basin) and M-091-20 (prepare T Plant to receive the first canister of sludge from the 100-K Basins).

ENVIRONMENTAL OCCURRENCES

Environmental releases of radioactive and regulated materials from the Hanford Site are reported to DOE and other federal and state agencies as required by law. The specific agencies notified depend on the type, amount, and location of the individual occurrence. The Hanford Site Occurrence Notification Center maintains both a computer database and a hardcopy file of event descriptions and corrective actions.

During 2002, there were no environmentally significant emergency occurrence reports or environmentally

significant unusual occurrence reports filed. Two off-normal occurrences with environmental impacts were reported. One was the spread of contamination after a period of high winds on January 21, 2002; additional soil fixatives are now being used at excavation sites. The second event was a spill of radioactive liquid at the TX Tank Farm. The liquid spilled from a water lance when it was removed from a tank. To prevent similar occurrences in the future, the O-ring materials will be changed, and the joint will be welded.



The Waste Treatment Plant is being built on 65 acres located on the Central Plateau outside of the Hanford 200-East Area.

ENVIRONMENTAL MANAGEMENT

A major focus of DOE's environmental management mission at Hanford is cleanup of the site's residual waste from more than 45 years of nuclear materials production. A major challenge is managing this legacy waste—which includes more than 50 million gallons of high-level liquid waste in 177 underground storage tanks, 2,300 tons of spent nuclear fuel, 12 tons of plutonium in various forms, about 25 million cubic feet of buried or stored solid waste, and about 270 billion gallons of groundwater contaminated above drinking water standards, spread out over about 80 square miles, more than 1,700 waste sites, and about 500 contaminated facilities—as well as other waste from past and current operations. The work involves safe storage, treatment, and final disposal of a large amount and variety of radioactive and chemical materials. It also involves remediating several hundred inactive waste disposal sites and stabilizing inactive facilities and the material inside them to prevent leaks or avoidable radiation exposures. Environmental restoration and pollution prevention are key parts of the environmental management mission.



The Hanford Site contains underground storage tanks that contain approximately 54 million gallons of hazardous and radioactive wastes.



There were 177 tanks built at the Hanford Site between 1943 and 1985. A major focus of DOE's mission is to clean up the legacy waste stored in these tanks.

WASTE STORAGE, TREATMENT, AND DISPOSAL

Waste management at Hanford includes designing, building, and operating a variety of facilities to store, treat, and prepare waste for disposal. At Hanford, a large part of this process involves safely managing 177 underground storage tanks that contain millions of gallons of high-level liquid waste.

Cleanup activities generate radioactive, hazardous, and mixed waste. This waste is handled and prepared for safe storage on the site or shipped to offsite facilities for treatment and disposal. In 2002, cleanup activities generated 2.2 million pounds of solid mixed waste and 3.5 million pounds of radioactive waste on the Hanford Site. Hanford received from offsite 246,199 pounds of mixed waste and 3.3 million pounds of radioactive waste. During 2002, 292,346 pounds of hazardous waste were shipped off the Hanford Site.

In addition to newly generated waste, significant quantities of legacy waste remain. Most legacy waste resides in waste sites that comply with the *Resource Conservation and Recovery Act* (RCRA) or is stored awaiting cleanup and ultimate safe storage or disposal. Examples include high-level radioactive waste stored in single- and double-shell tanks and transuranic waste stored in vaults and on storage pads.

WASTE TANKS

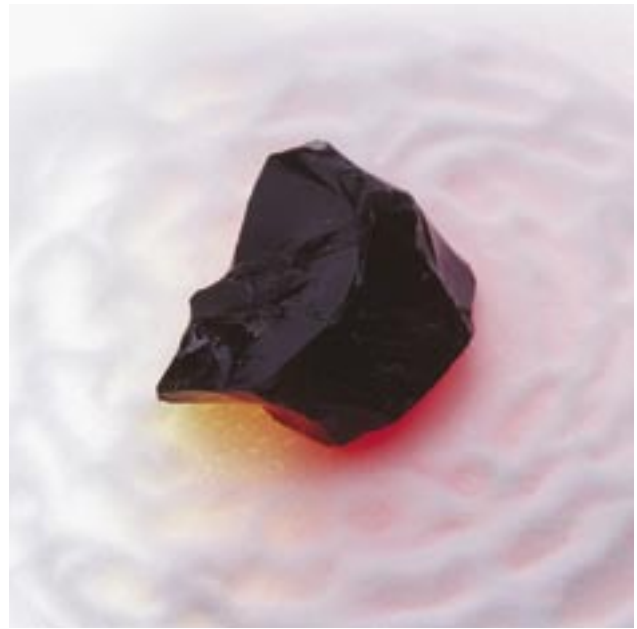
Sixty percent of the nation's nuclear waste is stored in tanks at the Hanford Site. DOE's goal is to safely remove the liquid waste from the tanks, separate the radioactive elements from non-radioactive chemicals, and create a solid form of waste that can be disposed. The approach selected to solidify the waste is called vitrification, a process that turns the waste into a rock-like glass.

Since the 1950s, waste leaks from 67 single-shell tanks have been detected, and some of this waste has reached groundwater underlying the 200 Areas. To date, scientists estimate that 750,000 to 1 million gallons of radioactive waste have leaked from single-shell tanks.

During 2002, three tanks were declared stable. Liquid waste from 17 single-shell tanks was pumped into the double-shell tank system, removing 1.4 million gallons of waste from the single-shell tanks. Of the single-shell tanks, 132 of 149 (89%) have been stabilized, and the tank stabilization program is on schedule to be completed by the end of September 2003.



DOE is evaluating vitrification methods and testing the melter process.



Vitrification turns waste into glass that appears hard, shiny, and rock like. The glass keeps waste from escaping into the environment.

IMMOBILIZATION OF WASTE CONTAINED IN UNDERGROUND TANKS

Approximately 54 million gallons of radioactive waste and hazardous waste are stored in 149 underground single-shell tanks and 28 underground double-shell tanks. This waste is an accumulation of more than 45 years of plutonium production operations on the DOE Hanford Site.

Radioactive waste is categorized as high level and low level. Hazardous waste contains either dangerous waste or extremely hazardous waste or both, as defined by Washington State. The high-level waste is stored in the underground tanks.

The DOE Office of River Protection currently is upgrading tank farm facilities to deliver waste from the underground storage tanks to a new Waste Treatment Plant.

The Waste Treatment Plant is being built on 65 acres located on the Central Plateau outside of the Hanford 200-East Area. The radioactive and hazardous waste stored in Hanford's underground waste tanks will be processed at this facility.

During 2002, the contractor began pouring concrete for the Pretreatment Plant, High-Level Waste Vitrification Plant, and the Low-Activity Waste Vitrification Plant. The potable water services and the sewage system for the Waste Treatment Plant began operating.

Treatment will separate the waste into a low-radioactivity fraction and a high-radioactivity and transuranic fraction. Both fractions will be vitrified in a process that will destroy or extract organic constituents, neutralize or deactivate dangerous waste, and immobilize toxic metals.

Vitrification uses electric power to melt soil and rock. The mass cools into glasslike blocks that will safely hold materials. The blocks appear hard, shiny and rock like. The glass traps the radioactive and hazardous waste and keeps it from escaping into the environment.

The immobilized low-radioactivity portion will be disposed of in a facility on the Hanford Site. The immobilized high-radioactivity fraction will be stored onsite until a geologic repository is available offsite for permanent disposal.

LIQUID WASTE MANAGEMENT

Liquid waste is managed in treatment, storage, and disposal facilities to comply with RCRA and state regulations, as briefly described below.

242-A Evaporator

The 242-A evaporator processes double-shell tank waste into a concentrate (that is returned to the tanks) and a process condensate stream that is sent to the Liquid Effluent Retention Facility. In 2002, the evaporator treated ~1 million gallons of tank waste, and the waste volume was reduced by ~413,500 gallons or 411%.

Liquid Effluent Retention Facility

This facility consists of three RCRA-compliant surface basins that temporarily store liquid waste, including condensate from the 242-A evaporator. Approximately 11.6 million gallons of liquid waste were stored in the facility's basins at the end of 2002.

Effluent Treatment Facility

Liquid effluent is treated in the Effluent Treatment Facility (200-East Area) to remove toxic metals, radionuclides, and ammonia and destroy organic compounds. The treated effluent is stored in verification tanks, sampled and analyzed, and discharged to the State-Approved Land Disposal Site (also known as the 616-A crib). Treatment capacity of the facility is a maximum of 150 gallons per minute. Approximately 22 million gallons of liquid waste were treated in 2002.

200 Area Treated Effluent Disposal Facility

This facility collects and disposes of non-RCRA-permitted waste that has been treated using best available technology/all known and reasonable treatment. During 2002, ~227.9 million gallons of effluent were treated and disposed of at two 5-acre ponds located east of the 200-East Area.

300 Area Treated Effluent Disposal Facility

Industrial wastewater generated throughout the Hanford Site is collected and treated in the 300 Area Treated Effluent Disposal Facility. The wastewater consists of once-through cooling water, steam condensate, and other industrial wastewater. The facility treated and disposed of 43.2 million gallons of industrial wastewater in 2002.



During 2002, the 242-A evaporator treated 1 million gallons of waste and reduced the volume by 413,500 gallons or about 411%.



The three basins shown in this photo of the Liquid Effluent Retention Facility are lined with two, flexible, high-density polyethylene membranes.



The 200 Area Treated Effluent Disposal Facility treats and stores radioactive waste.

SOLID WASTE MANAGEMENT

Treatment, storage, and disposal of solid waste takes place at a number of locations on the Hanford Site, such as those described in the following paragraphs. Solid waste may originate from work on the Hanford Site or from sources offsite that are authorized by DOE to ship waste to the site.

Central Waste Complex

Ongoing cleanup and research and development activities, as well as remediation activities, generate the waste received at the Central Waste Complex from on-site sources. Offsite waste comes primarily from DOE research facilities, other DOE sites, and Department of Defense facilities. The waste includes low-level, transuranic, and mixed waste, and radioactively contaminated polychlorinated biphenyls.

Waste Receiving and Processing Facility

The Waste Receiving and Processing Facility analyzes, characterizes, and prepares drums and boxes of waste for disposal. Waste destined for the facility includes Hanford's legacy waste as well as newly generated waste from current site cleanup activities.

T Plant Complex

The T Plant Complex in the 200-West Area provides waste treatment and storage and decontamination services for the Hanford Site. It operates under RCRA interim status.

Navy Reactor Compartments

Eight disposal packages containing defueled U.S. Navy reactor compartments were received and placed in the 200-East Area during 2002. Six were submarine reactor compartments, and two were cruiser reactor compartments. This brings the total number of reactor compartments received to 110. All Navy reactor compartments shipped to the Hanford Site for disposal have originated from decommissioned nuclear-powered submarines or cruisers.

Washington State Department of Ecology regulates the disposal of reactor compartments as dangerous waste because lead is used as shielding. The reactor compartments also are managed as mixed waste because of their radioactivity.



The Central Waste Complex receives waste from Hanford Site cleanup activities and from other DOE and Defense Department facilities.



The T Plant Complex operates under RCRA interim status. It provides waste treatment and storage and decontamination services to the Hanford Site.



Defueled reactor components from nuclear-powered submarines and cruisers are barged to the Hanford Site and buried in a trench in the 200-East Area.

Spent Nuclear Fuel Project

This project manages spent nuclear fuel and prepares it for long-term storage. In 2002, the project continued to make progress on an accelerated strategy to remove spent fuel from underwater storage in the 100-K Area Basins and placed it in dry interim storage in the 200-East Area. The spent fuel will be maintained in dry storage pending a decision by the Secretary of Energy on final disposition. Major accomplishments of the Spent Nuclear Fuel Project include the following items:

- A total of 805 tons of spent nuclear fuel were removed from the 100-K-West Basin and transported to the Cold Vacuum Drying Facility for processing and then taken to the Canister Storage Building for storage.
- A total of 260 fuel canisters (or ~90 tons) of spent nuclear fuel were transferred from the 100-K-East Basin to the 100-K-West Basin for cleaning and re-packaging before transport to the Cold Vacuum Drying Facility for processing.
- A total of 1,133 fuel storage canisters and 917 fuel storage canister lids were cleaned for disposal at the Environmental Restoration Disposal Facility. A total of 1,172 canisters were shipped to the Environmental Restoration Disposal Facility for disposal.
- Construction of the sludge removal system for the 100-K-East Basin progressed to 95% completion.
- Three cask shipments containing non-defense spent nuclear fuel was received for storage at the 200 Areas Interim Storage Area near the Canister Storage Building facility.

Central Plateau Remediation Project

This project's mission is to transition the Central Plateau from its post-operational state by deactivating and closing facilities until they can be turned over to the site contractor responsible for final disposition. The project includes the Accelerated Deactivation Project, 324 and 327 Facilities Deactivation Project, Equipment Disposition Project, 233-S Plutonium Concentration Facility Decommissioning Project, 200 Area Facilities Disposition Project, and the Canyon Disposition Project.

Advanced Reactors Transition Project

The goal of this project is to transition or convert the Plutonium Recycle Test Reactor facility, and facilities used for nuclear research, into structures that are in a safe and stable condition suitable for reuse or low cost surveillance and maintenance. The only facilities remaining to be cleaned up are in the southeastern part of the 300 Area, the high bay of the 337 Building, and the adjacent storage tank building, 3718M.

Plutonium Finishing Plant

During 1949, the Plutonium Finishing Plant began processing plutonium nitrate solutions into metallic form for shipment to nuclear weapons production facilities. Operation of this plant continued into the late 1980s. During 1986, DOE issued a shutdown order for the plant, authorizing deactivation and transition of the plutonium processing portions of the facility in preparation for decommissioning.

At the Plutonium Finishing Plant, today's mission is to stabilize, immobilize, re-package and/or properly dispose of materials containing plutonium, to deactivate and dismantle the processing facilities, and to provide for the safe and secure storage of nuclear materials until final disposal. Significant accomplishments achieved at the Plutonium Finishing Plant during 2002 included the following:

- Completed re-packaging of ~547 items of plutonium-bearing ash from a historical Hanford incinerator (February 2002).
- Completed stabilization of 1,189 gallons of plutonium-bearing solutions ahead of a revised Tri-Party Agreement milestone and nearly \$3 million under budget (July 2002).
- Began stabilizing over 860 plutonium-bearing polycubes using a unique thermal stabilization method devised specifically for this project. About 75% of polycubes, i.e., small cubes of polystyrene containing plutonium oxide, were stabilized by the end of 2002.
- Attained 1 million safe work hours and achieved safety Merit Status in DOE's Voluntary Protection Plan (November 2002).
- Continued welding stabilized plutonium forms into sturdy, triple-layered cans meeting strict specifications of DOE's "3013" safety standard.
- Completed re-packaging the entire "sand, slag, and crucible" group of plutonium-bearing residues for permanent disposal. Began re-packaging another large group of residues known as "mixed oxides" (December 2002).
- Stabilized more than 55% of the total plutonium inventory by the end of 2002, and advanced the stabilization completion date for the Plutonium Finishing Plant Project to February 2004.
- Deployed four field teams to clean up chemical residues and legacy plutonium held up in process equipment, as part of deactivation work; completed key environmental documentation in preparation for additional deactivation work and established an accelerated comprehensive deactivation schedule.



The Fast Flux Test Facility was built in the late 1970s to test plant equipment and fuel for the Liquid Metal Fast Breeder Reactor Program.

Fast Flux Test Facility

The Fast Flux Test Facility is a 400-megawatt thermal, liquid-metal, (sodium)-cooled reactor located in the 400 Area. It was built in the late 1970s to test plant equipment and fuel for the Liquid Metal Fast Breeder Reactor Program. The Fast Flux Test Facility operated from April 1982 to April 1992, during which time it successfully tested advanced nuclear fuels, materials, and safety designs and also produced a variety of isotopes for medical research.

The reactor has been in a standby mode since December 1993. Fuel has been removed from the reactor vessel and stored in two sodium-filled vessels and in above ground dry-storage casks. Twenty-three of the facility's 100 plant systems were deactivated during the previous deactivation period from 1993 to 1997.

During September 2002, deactivation and decommissioning activities were transferred from the DOE Office of Nuclear Energy to the DOE Office of Environmental Management, an indication of DOE's intention to permanently shut down the reactor.

In November 2002, Benton County filed a motion in the U.S. District Court for the Eastern District of Washington to halt decommissioning work on the Fast



The Fast Flux Test Facility is being readied for deactivation and decommissioning.

Flux Test Facility. Subsequently, Benton County and federal attorneys agreed to a 120-day stoppage of the deactivation activities.

In an effort to reduce shutdown costs and accelerate the decommissioning schedule, upgrades aimed at increasing the efficiency and reliability of the refueling system were the primary focus of 2002 activities. The acceptance test procedure for the closed-loop ex-vessel machine was completed on August 1, 2002, following 10 months of testing. The closed-loop ex-vessel machine was used to install the immersion heaters and is ready to support the commencement of fuel wash activities. Acceptance testing for the sodium removal system was completed in September 2002. Major repairs and modifications to the solid waste cask are nearing completion. Upon completion of the cask assembly, acceptance testing will begin.

During 2002, one argon and three nitrogen storage tanks were removed during the facility closure process. In addition, parts of the Mobiltherm and Containment Margins systems were removed before closure activities were put on hold. The Mobiltherm System was a heat transfer system used in the sodium purification process. The Containment Margins System was designed to vent the containment dome after a gas buildup caused by an accident.



By the end of 2002, the Environmental Restoration Disposal Facility had received over 3.98 million tons of contaminated soil and other waste.



This photo shows a well that is used as part of a ground-water pump-and-treat system in the 100-K Area. This system is reducing chromium contamination in ground-water near the Columbia River.

ENVIRONMENTAL RESTORATION

In 1994, DOE selected an environmental restoration contractor to perform environmental restoration projects at the Hanford Site. The Environmental Restoration Project involves characterizing and remediating contaminated soil and groundwater; stabilizing contaminated soil; and remediating disposal sites. It also involves decontaminating, decommissioning, and demolishing former plutonium production process buildings, nuclear reactors, and separation plants, and maintaining inactive waste sites.

Other roles of environmental restoration include transitioning facilities into the surveillance and maintenance program and mitigating effects to biological and cultural resources from site development and environmental cleanup and restoration activities.

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

This disposal facility is located near the 200-West Area and began operations in July 1996. Constructed with double liners and a leachate collection system, the

facility was designed to serve as the central disposal site for contaminated waste removed during cleanup operations conducted under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) on the Hanford Site.

Cleanup materials may include soil, rubble, or other solid waste materials contaminated with hazardous, low-level radioactive, or mixed (combined hazardous chemical and radioactive) waste. In 2002, the facility received waste for cells 3 and 4, which were constructed in 1999, and began disposing of waste in cell 2. At the end of 2002, the facility had received over 3.98 million tons of contaminated soil and other waste.

WASTE SITE REMEDIATION

Remediation continued through 2002 at several liquid waste disposal sites in the 100-B/C, 100-F, 100-K, 100-H, and 100-N Areas. In 2002, over 1 million tons of contaminated soil were removed from the remediation sites. This soil has been transported to the Environmental Restoration Disposal Facility since the beginning of waste site remediation operations in 1996.

STATUS OF WASTE SITE REMEDIATION

| Location of Waste Site | Amount of Contaminated Soil Removed |
|------------------------|---|
| 100-B/C Area | 151,000 tons in 2002, 957,000 since startup |
| 100-H Area | 455,000 tons since startup |
| 100-F Area | 307,000 tons in 2002, 824,000 since startup |
| 100-N Area | 134,731 tons in 2002, 285,853 since startup |
| 100-K Area | 5,321 tons in 2002 |

FACILITY DECOMMISSIONING PROJECT

Decontamination and decommissioning activities continued in 2002 in the 100-D/DR, 100-H, and 100-F Areas. These activities are conducted to support the interim safe storage of the four reactor buildings (D, DR, F, and H) for up to 75 years. Interim safe storage minimizes potential risks to the environment, employees, and the public and reduces surveillance and maintenance costs. These activities are conducted as non-time-critical removal actions under CERCLA. Demolition of D Reactor also was initiated in 2001 and progressed through three areas (the lunchroom, the valve pit and shops, and the fan room and ventilation system tunnels). Demolition work at F Reactor Fuel Storage Basin continues.

REVEGETATION AND MITIGATION PLANNING

The DOE Richland Operations Office and the U.S. Fish and Wildlife Service cooperatively worked on a plan to re-vegetate land on the Fitzner/Eberhardt Arid Lands Ecology Reserve to compensate for damage to the environment caused by the construction of cells 1 and 2 at the Environmental Restoration Disposal Facility. The Environmental Restoration Disposal Facility mitigation project includes three separate planting elements: a native grass seeding, shrub seedling planting, and native grass plug planting. Approximately 160 acres were planted with native grass seed, and 139,000 shrubs were planted across ~310 acres during 2002.

Monitoring of survival and growth continued for ~90,000 sagebrush seedlings that were planted on about 222 acres at nine locations on the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit during December 2000. This effort was the last phase of sagebrush transplanting as compensatory mitigation for the disturbance of sagebrush habitat resulting from the development of the site and infrastructure for the planned waste vitrification facility. Monitoring of these plants will continue through fiscal year 2004.

GROUNDWATER RESTORATION

The Groundwater Protection Project brings together all activities that affect Hanford's subsurface. Restoring the condition of the groundwater under the Hanford Site is a major focus of the project. The goals of groundwater restoration are to prevent contaminants from entering the Columbia River, reduce contamination in areas of high concentration, prevent the movement of contamination, and protect human health and the environment.

Pump-and-treat systems operated at the 100-D, 100-H, 100-K, 100-N, 200-East, and 200-West Areas in 2002. These systems pump contaminated groundwater out of the subsurface, treat it to remove the contaminants, and inject the clean water back into the aquifer. This common form of groundwater remediation is being used at Hanford to remove carbon tetrachloride, chromium, technetium-99, and uranium. The primary purpose of these pump-and-treat systems is to reduce the amount of contamination entering the river until a final cleanup solution is in place.

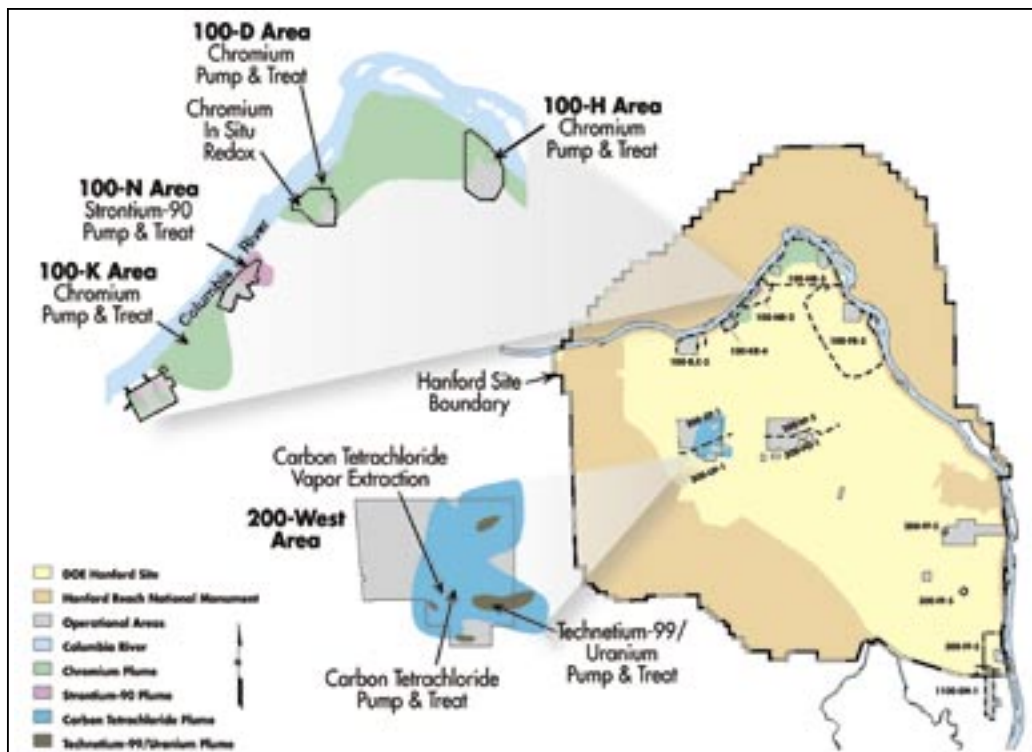
Soil-vapor extraction systems designed to remove carbon tetrachloride vapor from the vadose zone beneath the 200-West Area began operating during 1992 and continued through 2002. Since operations began, soil-vapor extraction has removed 171,515 pounds of carbon tetrachloride from the vadose zone.

During 1999, DOE initiated the development of an assessment tool that will enable the users to model the movement of contaminants from all waste sites at Hanford through the vadose zone, groundwater, and the Columbia River and estimate the impact of contaminants on human health, the ecology, and the local cultures and economies. This tool was named the System Assessment Capability. An initial assessment was completed during 2002 that provided the following information:

- Modeled the movement of contaminants from more than 500 locations throughout the Hanford Site, representing 890 waste sites, through the vadose zone, groundwater, and the Columbia River.
- Incorporated data on 10 radioactive and chemical contaminants (carbon tetrachloride, cesium-137, chromium, iodine-129, plutonium-239/240, strontium-90, technetium-99, tritium, total uranium, and uranium-238).
- Focused on subsurface transport, the Columbia River, and risks to human and ecological health, the economy, and culture.
- Included the geographic region from Rattlesnake Mountain to the Columbia River and from the Vernita Bridge to McNary Dam on the Columbia River.
- Included the cleanup actions in Hanford's cleanup plans and agreements as of October 2000.

SUMMARY OF GROUNDWATER REMEDIATION

| Location | Startup Date | Contaminant | Mass Removed (Groundwater Processed) in 2002 | Mass Removed (Groundwater Processed) Since Startup |
|--|--------------|----------------------|--|--|
| PUMP-AND-TREAT SYSTEMS | | | | |
| 100-D Area | 1997 | Hexavalent chromium | 63.3 pounds (43.96 million gallons) | 288 pounds (210.7 million gallons) |
| 100-H Area | 1997 | Hexavalent chromium | 7.3 pounds (48.6 million gallons) | 67.1 pounds (193.9 million gallons) |
| 100-K Area | 1997 | Hexavalent chromium | 77.8 pounds (117.7 million gallons) | 405.9 pounds (446.5 million gallons) |
| 100-N Area | 1995 | Strontium-90 | 0.20 curies (32.1 million gallons) | 1.3 curies (208.2 million gallons) |
| 200-West Area (200-ZP-1) Operable Unit | 1994 | Carbon tetrachloride | 2,130 pounds (74.2 million gallons) | 15,543 pounds (515.2 million gallons) |
| 200-West Area (200-UP-1) Operable Unit | 1994 | Carbon tetrachloride | 5.9 pounds (20.9 million gallons) | 51.4 pounds (167.4 million gallons) |
| | 1994 | Nitrate | 8,081 pounds (20.9 million gallons) | 53,255 pounds (167.4 million gallons) |
| | 1994 | Technetium-99 | 0.03 pounds (20.9 million gallons) | 0.21 pounds (167.4 million gallons) |
| | 1994 | Uranium | 60.8 pounds (20.9 million gallons) | 362.3 pounds (167.4 million gallons) |
| SOIL-VAPOR EXTRACTION | | | | |
| 200-West Area | 1992 | Carbon tetrachloride | 1,384.7 pounds | 171,545 pounds |



DOE operates five pump-and-treat systems on the Hanford Site to limit movement of contaminants in groundwater and the vadose zone.

The results are consistent with concentrations in environmental media measured by the Surface Environmental Surveillance Program and the Hanford Groundwater Monitoring Project. Both the monitoring results and the assessment indicate that Hanford's effect on the Columbia River has peaked and will decline if the cleanup actions currently planned are carried out. The initial assessment also identified some areas where an improvement to our understanding of the Hanford Site and how it is represented in this capability could improve the quality of our decisions. Completion of the initial assessment has provided information needed to design improvements to System Assessment Capability, a revision that will be designed to meet the requirements for the composite analysis, an assessment required by DOE Order 435.1.

The System Assessment Capability represents a holistic examination of the Hanford Site's radioactive and chemical waste legacy. For this reason, it can be used to examine the risk consequences of cleanup alternatives. To illustrate this, the assessment was re-run during 2002 without infiltration-reducing covers on waste sites. This action is not being considered for waste sites and was chosen only as a simple illustration of the capability. A four-fold increase in the amount of

technetium-99 released to groundwater was predicted for the no cover case. It also showed that covers have the greatest impact on mobile long-lived radionuclides that were not released with large volume discharges. This clearly points out the importance of surface barriers and covers that protect groundwater from enhanced infiltration, and provides useful information for cost-effective barrier design.

POLLUTION PREVENTION PROGRAM

This program focuses on conservation of resources and energy, reduction of hazardous substance use, and prevention or minimization of pollutant releases to all environmental media from all operations and site cleanup activities.

In 2002, the efforts of the program reduced the quantity of disposed waste by recycling 5 million cubic feet of radioactive and mixed waste, 812 tons of RCRA hazardous waste, and 4,339 tons of sanitary waste. The cost savings for waste disposal in 2002 exceeded \$37 million for these activities. During 2002, the Hanford Site also recycled 603 tons of paper products and 616 tons of various metals.



The total dose to the maximally exposed individual was calculated as 0.02 mrem/year, the same dose a person would receive flying 2.67 miles on an airliner.

POTENTIAL RADIOLOGICAL DOSES FROM 2002 HANFORD OPERATIONS

In 2002, scientists evaluated potential radiological doses to the public and biota resulting from exposure to Hanford Site liquid effluents and airborne emissions to determine compliance with pertinent regulations and limits. The potential dose to the maximally exposed individual in the Riverview area of Pasco, Washington, during 2002 from site operations was 0.02 millirem.

The current DOE radiological dose limit for a member of the public is 100 millirem per year. Therefore, the maximally exposed individual potentially received 0.02% of the DOE limit. Primary pathways contributing to this dose were the Columbia River—including consumption of fish, consumption of foods irrigated with water withdrawn downstream of Hanford, and consumption of river water containing uranium-234, uranium-238, and tritium, and inhalation of air and consumption of food products grown downwind of Hanford, due principally to airborne releases of tritium from the 300 Area.

SUMMARY OF POTENTIAL RADIOLOGICAL DOSES FROM 2002 HANFORD OPERATIONS

| Radiological Dose | Dose Parameters | Dose |
|--|---|-------------------------|
| Average radiological dose from natural sources and consumer products | The dose includes sources such as cosmic, terrestrial, internal, and radon. | 300 millirem per year |
| DOE's annual radiological dose limit for a member of the public | The dose includes air, drinking water, food, recreation, and external radiation exposure pathways. | 100 millirem per year |
| Maximally exposed individual | This hypothetical person's diet, dwelling place, and other factors were chosen to maximize the combined doses from all reasonable environmental pathways of exposure to radionuclides in Hanford Site effluents and emissions. In 2002, this individual was located in the Riverview Area of Pasco, Washington. | 0.02 millirem per year |
| Collective dose | The collective dose is based on a population residing within 80 kilometers (50 miles) of Hanford Site operating areas. | 0.3 person-rem per year |
| Maximum Hanford Site boundary dose | Boundary dose rates are not used to calculate annual doses to the general public because no one can actually reside at the boundary locations. The highest boundary location exposure rate in 2002 was measured along the 100-N Area shoreline of the Columbia River. The maximum boundary dose is based on thermoluminescent dosimeter readings. | 0.011 millirem per hour |
| Dose to people consuming drinking water at the Fast Flux Test Facility | The potential dose to Fast Flux Test Facility workers assumes a consumption of 0.26 gallon per day of drinking water from onsite wells for 240 days. | ~0.02 millirem per year |
| Maximum dose to non-DOE workers on the site (per <i>Clean Air Act</i> standards) | Doses to members of the public employed at non-DOE facilities that were outside access-controlled areas on the Hanford Site; only considers the air pathway, not water pathway. | 0.014 millirem per year |
| Individual dose from non-DOE sources | Various non-DOE industrial sources of public radiation exposure exist at or near the Hanford Site. | ~0.05 millirem per year |



Information from thermoluminescent dosimeters is collected across the Hanford Site and at offsite locations. This device measures radiation absorbed dose.

ENVIRONMENTAL MONITORING

Environmental monitoring at the Hanford Site includes near-facility environmental monitoring, surface environmental surveillance, groundwater monitoring, and vadose zone monitoring. Near-facility monitoring includes the analysis of environmental samples collected near major nuclear-related installations, waste storage and disposal units, and remediation sites. Surface environmental surveillance consists of sampling and analyzing various media on and around the site to detect potential contaminants and to assess their significance to environmental and human health. Groundwater sampling is conducted on the site to determine the distribution of radiological and chemical constituents in groundwater. The strategy for managing and protecting groundwater resources at the Hanford Site focuses on protection of the Columbia River, human health, the environment, treatment of groundwater contamination, and limitation of groundwater migration. Vadose monitoring and characterization is conducted to better understand the physical and chemical properties of the vadose zone and vadose zone contamination. Environmental monitoring and surveillance results for 2002 are summarized in the following table.

HANFORD SITE MONITORING RESULTS FOR 2002

| | WHAT WAS MONITORED? | THE BOTTOM LINE |
|----------------------------------|--|--|
| Air | Air sampling equipment collected particles and gases, which were analyzed for radioactive materials. Air was sampled at 24 locations on Hanford, at 11 perimeter locations, in 8 nearby communities, and in 2 distant communities. In addition, near-facility monitoring collected air samples at 82 locations near Hanford facilities. | All measurements of radioactive materials in air were below recommended guidelines. |
| Columbia River Water | Columbia River water was collected from multiple sampling points throughout the year. Water samples were analyzed for radioactive and chemical materials. Water in the Columbia River continues to be designated Class A (Excellent) by the state of Washington. This designation means the water is usable for substantially all needs. | As in past years, small amounts of radioactive materials and chemicals were seen in river water samples collected near and downstream of the site. |
| Columbia River Shoreline Springs | Groundwater discharges to the Columbia River along the Hanford Site that are above the water level of the river are identified as riverbank springs. Samples of spring water were collected at locations along the Columbia River shoreline. | Samples collected at the springs contained some contaminants at levels above drinking water standards. However, concentrations in river water downstream of the shoreline springs remained far below federal and state limits. |
| Groundwater | Groundwater samples were collected from 658 wells to monitor contaminant concentrations. Water levels were measured in several hundred wells on the site to map groundwater movement. | Samples show that groundwater contaminant plumes are moving slowly from beneath former waste sites toward the Columbia River. Contaminant concentrations are declining in the largest plumes because of spreading and radioactive decay. |
| Vadose Zone | The vadose zone is the region between the ground surface and the top of the water table. Vadose zone characterization and monitoring are conducted to better understand the physical and chemical properties of the vadose zone and vadose zone contamination. | Vadose zone characterization was conducted at five operable units in the 200 Areas. Vadose zone monitoring occurred at the tank farms in the 200-East and 200-West Areas. Technical demonstrations are designed to result in new, innovative methods for environmental monitoring and cleanup on the Hanford Site. In 2002, 13 technical studies were conducted. |
| Drinking Water | The quality of the drinking water supplied by nine DOE-owned systems on the Hanford Site was monitored. | All DOE-owned drinking water systems on the Hanford Site met Washington State and EPA regulations. |
| Food and Farm Products | Samples of cherries, leafy vegetables, milk, potatoes, tomatoes, and wine were collected from 17 locations upwind and downwind of the Hanford Site. | Radionuclide levels in samples of food and farm products were at normal environmental levels. |
| Fish and Wildlife | Game animals on the site and along the Hanford Reach and fish from the Columbia River were monitored at 13 locations. Carcass, bone, and muscle samples were analyzed to evaluate radionuclide levels. | Samples of carp, bass, California quail and mule deer were collected and analyzed. Radionuclide levels in wildlife samples were well below levels that are estimated to cause adverse health effects to animals or to the people who many consume them. |
| Effluent Monitoring | Liquid effluent and airborne emissions that may contain radioactive or hazardous constituents are continually monitored on the Hanford Site. | Some quantities of radionuclides were released to the environment at state and federally permitted release points. Compliance with all applicable effluent monitoring requirements was achieved in 2002. |



Air samplers on the site were located primarily around major operational areas to maximize the ability to detect radiological contaminants resulting from site operations.



Most radionuclides in airborne emissions from the site are nearing levels indistinguishable from the low concentrations in the environment that occur naturally or originated from atmospheric nuclear weapons testing.

FACILITY EFFLUENT MONITORING

Liquid and airborne effluents that may contain radioactive or hazardous constituents are continually monitored when released to the environment at the Hanford Site. Facility operators perform the monitoring mainly through analyzing samples collected at points of release into the environment.

Effluent monitoring data are evaluated to determine the degree of regulatory compliance for each facility and/or the entire site. The evaluations are also useful to assess the effectiveness of effluent treatment and pollution-management practices.

In 2002, only facilities in the 200 Areas discharged radioactive liquid effluents to the ground, which went to a state permitted disposal site. Radioactive air emissions usually come from a building stack or vent. Radioactive emissions discharge points are located in the 100, 200, 300, 400, and 600 Areas.

Non-radioactive air pollutants from such things as diesel-powered electrical generating plants were monitored. In 2002, the 200 Areas tank farms produced reportable ammonia emissions.

RADIOACTIVE LIQUID EFFLUENTS

Liquid effluents are discharged from facilities at the Hanford Site. Effluents that normally or potentially contain radionuclides include cooling water, steam condensate, process condensate, and wastewater from laboratories and chemical sewers. These wastewater streams are sampled and analyzed for gross alpha and gross beta levels as well as for selected radionuclides.

RADIOACTIVE AIRBORNE EMISSIONS

Radioactive airborne emissions from the Hanford Site to the surrounding region are a potential source of human exposure. Most of the radionuclides in effluent at the site are nearing levels indistinguishable from the low concentrations in the environment that occur naturally or originated from atmospheric nuclear weapons testing. The environmental cleanup mission is largely responsible for the downward trend in radioactive emissions at Hanford.



In 2002, 60 radioactive emission discharge points were active in the 200 Areas.

The continuous monitoring of radioactive emissions involves analyzing samples collected at points of discharge to the environment, usually from a stack or vent. Samples are analyzed for gross alpha and gross beta concentrations as well as for selected radionuclides.

Selection of specific radionuclides sampled, analyzed, and reported is based on (1) an evaluation of maximum potential of unmitigated emissions hypothetically expected from known radionuclide inventories in a facility or outside activity area, (2) the sampling criteria given in contractor environmental compliance manuals, and (3) the potential of each radionuclide to exceed normal operating ranges by levels requiring immediate personnel alert.

Radioactive discharge points, which generally are actively ventilated stacks, are located in the 100, 200, 300, 400, and 600 Areas. The main sources for those emissions are summarized in the following paragraphs

In the 100 Areas, radioactive airborne emissions originated from four points: evaporation at the water-filled 100-K East and 100-K West Fuel Storage Basins (which contain irradiated nuclear fuel), the Cold Vacuum Drying Facility, the 105-KW integrated water treatment filter system, and a low-level radiological laboratory.



Radioactive air emissions usually come from a building stack or vent. These stacks were demolished as part of site decontamination and decommissioning activities.

In the 200 Areas, primary sources of radionuclide emissions were the Plutonium Finishing Plant, T Plant, the inactive Plutonium-Uranium Extraction Plant, the Waste Encapsulation and Storage Facility, underground waste storage tanks, and waste evaporators. In 2002, 60 radioactive-emission discharge points were active in the 200 Areas.

The 300 Area primarily has laboratories and research facilities. Primary sources of airborne radionuclide emissions were the 324 Waste Technology Engineering Laboratory, 325 Applied Chemistry Laboratory, 327 Post-Irradiation Laboratory, and 340 Vault and Tanks. During 2002, there were 24 radioactive-emission discharge points in the 300 Area.

The 400 Area has the shutdown Fast Flux Test Facility, the Maintenance and Storage Facility, and the Fuels and Materials Examination Facility. During 2002, there were five radioactive-emission discharge points in the 400 Area.

The 600 Area has the Waste Sampling and Characterization Facility, at which low-level radiological and chemical analyses are performed on various types of samples. During 2002, the 600 Area had two radioactive-emission discharge points active, both at the Waste Sampling and Characterization Facility.



Monitoring locations are associated with nuclear facilities such as the Plutonium Finishing Plant, Canister Storage Building, and inactive nuclear facilities.



During 2002, personnel collected air samples from a network of continuously operating samplers at 82 locations near onsite facilities.

NEAR-FACILITY MONITORING

Near-facility environmental monitoring is defined as routine monitoring near facilities that have the potential to discharge, or have discharged, stored, or disposed of radioactive or hazardous contaminants.

Monitoring locations are associated with nuclear facilities such as the Plutonium Finishing Plant, Canister Storage Building, and the 100-K Area Fuel Storage Basins; inactive nuclear facilities such as N Reactor and the Plutonium-Uranium Extraction Plant; and active and inactive waste storage or disposal facilities such as burial grounds, cribs, ditches, ponds, underground waste storage tanks, and trenches.

AIR

During 2002, routine monitoring for radioactivity in air near Hanford Site facilities used a network of continuously operating samplers at 82 locations.

Air samplers were located primarily at or within ~1,500 feet of sites and/or facilities having the potential for, or history of, environmental releases and were predominantly located in the prevailing downwind direction.

Air samples collected in 2002 from areas located at or directly adjacent to Hanford Site facilities had higher radionuclide concentrations than did those samples collected farther away. In general, radionuclide concentrations in most air samples collected near facilities in 2002 were at or near background levels.

SPRING WATER

Groundwater springs and/or shoreline seepage wells at the 100-N Area's N Springs are sampled annually to verify that the reported radionuclide releases to the Columbia River are not underreported.

The amount of radionuclides entering the Columbia River at these springs (i.e., release) is calculated based on analyses of monthly samples collected from monitoring well 199-N-46 located near the shoreline.

During 2002, the concentration of strontium-90 detected in samples from N Springs did not exceed the DOE derived concentration guide. Tritium and gamma-emitting radionuclide concentrations were below analytical detection limits in 2002.



Soil samples are collected on the Hanford Site near waste disposal sites and from locations downwind and near or within the boundaries of operating facilities and remedial action sites.

SOIL AND VEGETATION

Near-facility soil and vegetation sampling is conducted to detect the potential migration and deposition of facility effluents and emissions. During 2002, 82 soil samples and 63 vegetation samples were collected for analysis.

The samples were collected on or adjacent to waste disposal sites and from locations downwind and near or within the boundaries of operating facilities and remedial action sites.

In near-facility soil samples, cobalt-60, strontium-90, cesium-137, plutonium-239/240, and uranium were detected consistently in 2002. The concentrations of these radionuclides were elevated near and within facility boundaries when compared to historical concentrations measured off the site.

In near-facility vegetation samples, cobalt-60, strontium-90, cesium-137, plutonium-239/240, and uranium were detected consistently in 2002. Concentrations of these radionuclides in vegetation were elevated near and within facility boundaries compared to concentrations measured off the site. The results demonstrate a high degree of variability.



Investigative samples collected in 2002 included water, animals, animal feces, soil, and vegetation.

INVESTIGATIVE SAMPLING

Investigative sampling was conducted in the operations areas to monitor the presence or movement of radioactive and/or hazardous materials around areas of known or suspected contamination or to verify radiological conditions at specific project sites.

Investigative samples collected in 2002 included soil, vegetation, animals, animal feces, and water. During 2002, there were 22 instances of radiological contamination in investigative soil samples. Of the 22, 16 were identified as speck or soil speck contamination. None of the investigative soil samples were submitted for radioisotopic analysis.

In 2002, there were 16 instances of radiological contamination in investigative vegetation samples. During 2002, techniques for herbicide application were improved, and administrative procedures were implemented to improve vegetation management.

In 2002, 10 wildlife and wildlife-related samples were collected, three of which were submitted for laboratory analysis. Contaminants included strontium-89/90 and cesium-137.



Airborne radionuclide samples were collected at four community-operated environmental surveillance stations that were managed and operated by local school teachers.



Monitoring air particulate (dust) is done using tapered element oscillating microbalances (TEOM). The instruments record hourly average concentrations.

SURFACE ENVIRONMENTAL SURVEILLANCE

The Surface Environmental Surveillance Project monitors the concentrations of radionuclides and chemicals in environmental media and assesses the potential effects of these materials on the environment and the public. Samples of air, surface water, sediment, soil, natural vegetation, agricultural products, fish, and wildlife are collected routinely or periodically. Analyses include the measurement of radionuclides at very low environmental levels and chemicals, including metals and anions. In addition, ambient external radiation is measured.

AIR

Atmospheric releases of radioactive material from the Hanford Site to the surrounding region are a potential source of human exposure.

Airborne radionuclide samples were collected at 45 continuously operating samplers: 24 on the Hanford Site, 11 near the site perimeter, 8 in nearby communities, and 2 in distant communities. Four of the stations were community-operated environmental surveillance stations that were managed and operated

by local school teachers as part of an ongoing DOE-sponsored program to promote public awareness of Hanford Site environmental monitoring programs.

The potential influence of emissions from Hanford Site activities on local radionuclide concentrations was evaluated by comparing differences between concentrations measured at distant locations within the region and concentrations measured at the site perimeter.

During 2002, the average gross alpha air concentrations measured at Hanford were higher than average levels measured at a distant location. However, the differences were not statistically significant. The average gross alpha concentrations measured from 1997 through 2001 were slightly higher than the average concentrations observed during 2002.

The annual average gross beta concentration measured in air on the site in 2002 was slightly higher than the average gross beta concentration measured at the distant location; however, the difference was not statistically significant. The average gross beta concentrations reported during 2002 were similar to concentrations reported from 1997 through 2001.

Average tritium concentrations measured were slightly higher than average values reported for 1997 through 2001. The highest measured concentration was only 0.033% of the DOE derived concentration guide.

Iodine-129 analyses were performed on samples collected downwind of the Plutonium-Uranium Extraction Plant, at two downwind perimeter locations, and at a distant location. Concentrations measured onsite were elevated compared to those measured at the perimeter and distant locations, indicating a Hanford source. Onsite and perimeter air concentrations have remained at about the same levels from 1997 through 2002.

Plutonium-238 was detected in three samples from the 100 Areas. The maximum concentration, however, was 7,000 times less than the DOE derived concentration guide for plutonium-238.

AIR PARTICULATE MONITORING

Monitoring of airborne particulate matter (dust) began during February 2001, after the decrease in vegetative cover from the 2000 wildfire. Data are collected at the Hanford Meteorology Station near the 200-West Area. The EPA 24-hour average standard concentration for PM₁₀ is 150 µg/m³. Daily average concentrations measured on the Hanford Site exceeded that limit three times in 2002. These exceedances appeared to be the result of high winds.

SURFACE WATER, SEDIMENT, AND DRINKING WATER

Samples of surface water and sediment on and near Hanford were collected and analyzed to determine potential impacts to the public and aquatic environment from Hanford-originated contaminants.

Surface water bodies included in routine surveillance were the Columbia River and its associated riverbank springs, onsite ponds, and offsite irrigation sources. Water in the Columbia River continues to be designated Class A (Excellent) by the state. This designation means the water is usable for substantially all needs. Sediment surveillance was conducted for the Columbia River and riverbank springs. The quality of drinking water on the Hanford Site also is monitored routinely.



Airborne radionuclide samples were collected at 45 continuously operating samplers located on and around the Hanford Site.



Monitoring dust takes place near the 200 Areas and helps determine air quality.



The quality of drinking water on the Hanford Site is routinely monitored.



Samples of Columbia River water are collected at the Richland Pumphouse.

Columbia River Water

Radiological and chemical contaminants enter the Columbia River along the Hanford Reach through (1) seepage of contaminated groundwater, and (2) permitted, direct-discharge of liquid effluent from Hanford facilities. Water samples were collected from the river at various locations throughout the year and analyzed to determine compliance with applicable water quality standards.

All radiological contaminant concentrations measured in Columbia River water in 2002 were less than DOE derived concentration guides and Washington State ambient surface-water quality criteria levels. The concentrations of tritium, iodine-129, and total uranium were significantly higher (5% significance level) at the Richland Pumphouse (downstream from the site) than at Priest Rapids Dam (upstream from the site), indicating a contribution from Hanford along the Hanford Reach. All concentrations were similar to those observed in recent years.

Transect (multiple samples collected across the river) and near-shore sampling in 2002 revealed elevated tritium levels along the Benton County shoreline near the 100-N Area, Hanford town site, 300 Area, and Richland Pumphouse.



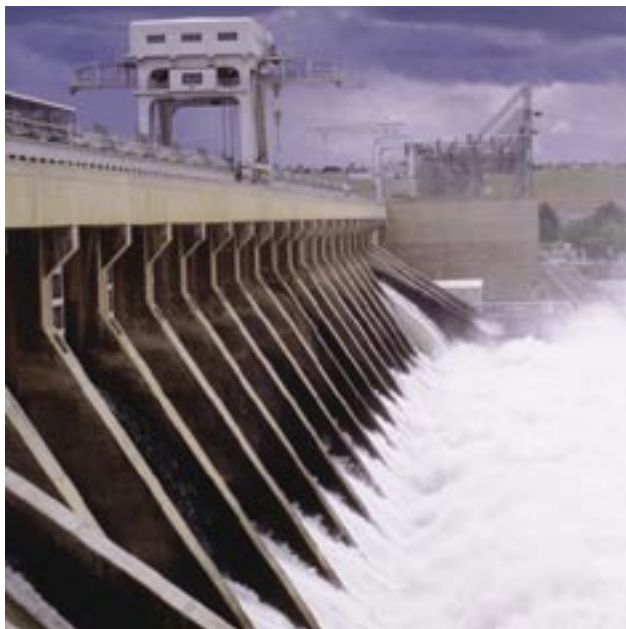
Water samples were collected from the Columbia River at various locations near Hanford and analyzed to determine compliance with water quality standards.

Total uranium concentrations were elevated along the Franklin County shoreline near the 300 Area and the Richland Pumphouse and likely resulted from groundwater seepage and water from irrigation return canals on the east shore of the river that contained naturally occurring uranium. Slightly elevated strontium-90 concentrations were detected in some water samples collected at near-shore locations at the 100-N Area.

Several metals and anions were detected in transect samples collected upstream and downstream of the site. Arsenic, antimony, cadmium, chromium, lead, nickel, thallium, and zinc were detected in most samples, with similar levels at most locations.

Nitrate, sulfate, and chloride concentrations were slightly elevated, compared to mid-river samples, at the Hanford town site and along the Franklin County shoreline at the Richland Pumphouse transects. The elevated Franklin County values likely resulted from groundwater seepage associated with extensive irrigation north and east of the Columbia River.

All metal and anion concentrations (including arsenic) in Columbia River water samples collected in 2002 were below regulatory limits and similar to those observed in the past.



Samples of Columbia River surface sediment were collected at the McNary Dam pool downstream of the Hanford Site.

Columbia River Sediment

During 2002, samples of Columbia River surface sediment were collected at the McNary Dam pool (downstream of the site), from the Priest Rapids Dam pool (upstream of the site), and along the Hanford Reach (including some riverbank springs).

Radionuclides consistently detected in river sediment sampled adjacent and downstream of the Hanford Site during 2002 included potassium-40, cesium-137, uranium-238, plutonium-238, and plutonium-239/240. The concentrations of all other radionuclides were below detection limits for most samples. Cesium-137 and plutonium isotopes exist in worldwide fallout, as well as in effluents from Hanford Site facilities. Uranium occurs naturally in the environment in addition to being present in Hanford Site effluents. Radionuclide concentrations reported in river sediment in 2002 were similar to those reported for previous years. No federal or state freshwater sediment criteria are available to assess the sediment quality of the Columbia River.

Riverbank Spring Water

All riverbank spring water samples collected during 2002 were analyzed for gamma-emitting radionuclides, gross alpha, gross beta, and tritium. Samples



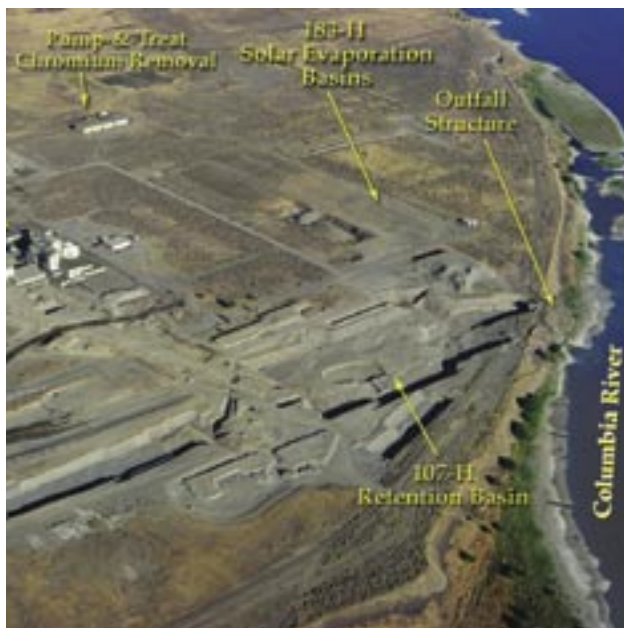
Water samples from riverbank springs entering the Columbia River along the Hanford Site were collected at several locations in 2002.

from selected springs were analyzed for strontium-90, technetium-99, iodine-129, and uranium-234, uranium-235, and uranium-238. All samples were analyzed for metals and anions, with volatile organic compounds analyzed at selected locations.

Hanford-origin contaminants continued to be detected in water from riverbank springs entering the Columbia River along the Hanford Site during 2002. Tritium, strontium-90, technetium-99, iodine-129, uranium-234, uranium-235, and uranium-238, metals, and anions (chloride, fluoride, nitrate, and sulfate) were detected in spring water. Volatile organic compounds were near or below the detection limits for most samples.

All radiological contaminant concentrations measured in riverbank springs in 2002 were less than the DOE derived concentration guides.

Tritium concentrations in water samples collected in 2002 from riverbank springs at the Hanford town site (maximum concentration was 58,000 picocuries per liter) exceeded the state ambient surface-water quality criteria level of 20,000 picocuries per liter. The maximum tritium concentration in riverbank spring water collected in 2002 at the 100-N Area was 36% of the state ambient surface-water quality criteria level.



Concentrations of chromium in the 100-B, 100-D, 100-F, 100-H, 100-K, 100-N, and 300 Areas spring water were above the state ambient surface water chronic toxicity levels.

At the 300 Area, the maximum tritium level was 40% of the criteria. The maximum strontium-90 concentration in riverbank spring water was measured at the 100-H Area location and was 41% of the state ambient surface-water quality criteria. Total uranium concentrations exceeded the EPA drinking water standard for both riverbank spring water samples collected in the 300 Area. The gross alpha concentration also exceeded the ambient surface-water quality criteria level in riverbank spring water at the 300 Area, which is consistent with the elevated uranium levels. All other radionuclide concentrations in 300 Area springs water were less than the state ambient surface-water quality criteria levels. Gross beta concentrations in riverbank spring water at the 100-B Area, 100-H Area, Hanford town site, and 300 Area were elevated compared to other riverbank spring water locations.

Most metal concentrations measured in water from riverbank springs located on the Hanford shoreline in 1999 through 2002 were below Washington State ambient surface-water acute toxicity levels. However, concentrations of chromium in the 100-B, 100-D, 100-F, 100-H, 100-K, 100-N, and 300 Areas spring water were above the state ambient surface water chronic toxicity levels. Arsenic concentrations in water from riverbank springs water were well below the applicable state ambient surface-water chronic toxicity



In 2002, sediment samples were collected at riverbank springs in the 100-B, 100-F, and 300 Areas.

levels, but concentrations in all samples exceeded the federal limit for the protection of human health for the consumption of drinking water. Nitrate concentrations at all locations were below the EPA drinking water standard.

Riverbank Spring Sediment

In 2002, sediment samples were collected at riverbank springs in the 100-B, 100-F, and 300 Areas. There was no sediment available for sampling at the 100-K and 100-N Area locations. In 2002, radionuclide concentrations in riverbank springs sediment were similar to those observed in river sediment with the exception of the 300 Area where elevated uranium concentrations were observed.

Detectable amounts of most metals were found in all river sediment samples in 2002. Maximum and median concentrations of most metals were higher for sediment collected at Priest Rapids Dam compared to either Hanford Reach or McNary Dam sediment. The concentrations of cadmium, chromium, lead, nickel, thallium, and zinc had the largest differences between locations. Metal concentrations in riverbank springs sediment samples in 2002 were similar to concentrations in Hanford Reach sediment samples. Currently, there are no Washington State freshwater sediment quality criteria for comparison to the measured values.



Irrigation canal water was sampled three times in 2002 during the irrigation season. Samples were analyzed for radionuclide concentrations.

Onsite Pond Water and Sediment

Water was collected from the Fast Flux Test Facility process water pond, and water and sediment were collected from West Lake. The ponds are inaccessible to the public but were accessible to migratory waterfowl and other animals, creating a potential biological pathway for dispersion of contaminants. All radionuclide concentrations in onsite pond water were less than the DOE derived concentration guides and state ambient surface-water quality criteria levels. West Lake sediment had detectable concentrations for gross alpha, gross beta, potassium-40, strontium-90, cesium-137, and uranium isotopes.

Offsite Water

Water samples were collected from an irrigation canal located across the Columbia River and downstream from the Hanford Site at Riverview and from the Horn Rapids irrigation pumping station. As a result of public concerns about the potential for Hanford-associated contaminants in offsite water, sampling was conducted to document the levels of radionuclides in water used by the public. Consumption of vegetation irrigated with Columbia River water downstream of the site has been identified as one of the primary pathways contributing to the potential dose to the hypothetical maximally exposed individual and any other member of the public.



Radionuclide concentrations measured in irrigation water were at the same levels detected in the Columbia River. All concentrations were below the state ambient surface-water criteria levels.

Water in the Riverview irrigation canal and the Horn Rapids pumping station was sampled three times in 2002 during the irrigation season. Unfiltered samples of the canal water were analyzed for gross alpha, gross beta, gamma emitters, tritium, strontium-90, and uranium-234, uranium-235, and uranium-238. In 2002, radionuclide concentrations measured in irrigation water were at the same levels detected in the Columbia River. All radionuclide concentrations were below the DOE derived concentration guides and state ambient surface-water quality criteria levels.

Hanford Site Drinking Water

The quality of Hanford Site drinking water is monitored by collecting and analyzing drinking water samples and comparing the resulting analytical data with established drinking water standards and guidelines.

The national primary drinking water regulations of the *Safe Drinking Water Act* apply to the drinking water supplies at the Hanford Site. In Washington, these regulations are enforced by the Department of Health.

All DOE-owned drinking water systems on the Hanford Site were in compliance with Washington State and EPA annual average radiological drinking water standards in 2002, and results were similar to those observed in recent years.

FOOD AND FARM PRODUCTS

Food products, including milk, vegetables, fruit, and wine, were collected routinely in 2002 at several locations surrounding the site. Samples were collected primarily from locations in the prevailing downwind directions where airborne effluents or fugitive dust from the site could be deposited. Samples were collected upwind and at distant locations to provide information on reference radiation levels in foodstuff.

Routine food and farm product sampling determines the potential influence of Hanford Site releases by comparing results from (1) downwind locations to those from generally upwind or distant locations; (2) the same regions over long periods of time; and (3) locations irrigated with Columbia River water withdrawn downstream from the Hanford Site to results from locations irrigated with water from other sources.

Milk was analyzed for strontium-90, iodine-129, and gamma-emitting radionuclides such as cesium-137 and tritium. Strontium-90 was not detected in the milk samples analyzed in 2002. There were no gamma-emitting radionuclides detected in milk during 2002.

Concentrations of strontium-90, gamma-emitting radionuclides, and tritium were measured in vegetable samples. Neither strontium-90 nor tritium was detected in any vegetable sample collected during 2002.

Measurements of gamma-emitting radionuclides in vegetables were all less than their respective detection limit in 2002 and were consistent with results seen in recent years.

Cherry samples were analyzed for gamma-emitting radionuclides and strontium-90. Measurable levels of cesium-137 were reported in cherries collected from the Riverview area. No other radionuclides were detected in cherries in 2002.

Two samples each of red and white wine were obtained from the Columbia Basin and Yakima Valley. They were analyzed for gamma-emitting radionuclides and tritium. Tritium concentrations in wine samples were consistent with past results. There were no gamma-emitting radionuclides measured in 2002 wine samples.



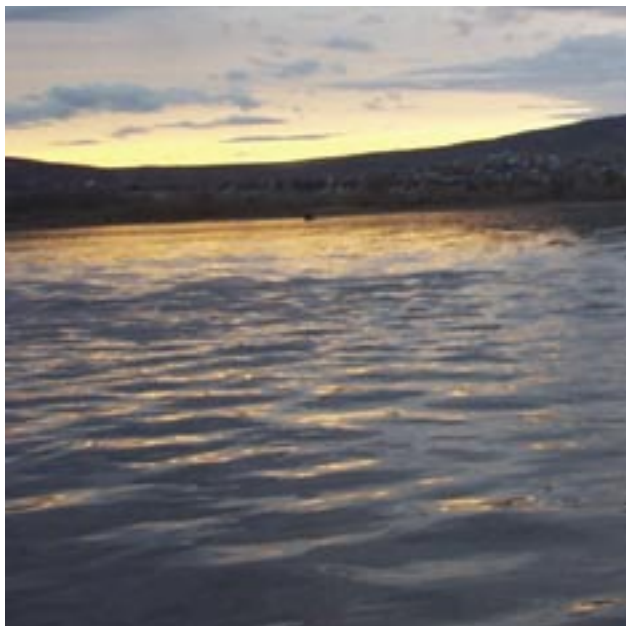
Food product samples, including potatoes, were collected at several locations surrounding the Hanford Site.



Routine food and farm product sampling determines the potential influence of Hanford Site releases.



Cherry samples were analyzed for gamma-emitting radionuclides and strontium-90.



Monitoring fish and other organisms for uptake and exposure to radionuclides is important in tracking the extent and long-term trends of contamination in the Columbia River environment.

FISH AND WILDLIFE

Contaminants in fish and wildlife that inhabit the Columbia River and Hanford Site are monitored for several reasons. Wildlife have access to areas of the site containing radioactive or chemical contamination, and fish can be exposed to contamination entering the river along the shoreline.

Fish and some wildlife species exposed to Hanford contaminants might be harvested for food and may potentially contribute to offsite public exposure. However, the amount of radiological contamination measured in fish and wildlife samples is well below levels known to cause adverse health effects. In addition, detection of contaminants in wildlife may indicate that wildlife are entering contaminated areas (burrowing in waste burial grounds) or that materials are moving out of contaminated areas (through blowing dust or food-chain transport). Consequently, fish and wildlife samples are collected at selected locations annually.

Fish Samples

The amounts of radiological contamination measured in fish samples are well below levels that are known to cause adverse biological effects and contribute only a small proportion of the radiation dose to the maximally



Thirteen smallmouth bass were collected during 2002 in the Columbia River and analyzed for a variety of radiological contaminants.

exposed individual. However, monitoring fish and other organisms for uptake and exposure to radionuclides at both nearby and distant locations continues to be important to track the extent and long-term trends of contamination in the Columbia River environment.

In 2002, 15 carp were collected from three locations in the Columbia River: near the 100-N Area, near the 300 Area, and from an upstream reference site near Vantage, Washington. Thirteen smallmouth bass were also collected during 2002 from two backwater areas along the Hanford Reach, near the 300 Area, and from an upstream reference area near Vantage, Washington. Fillets and the eviscerated remains (carcass) of fish were analyzed for a variety of radiological contaminants and results from the nearby and distant locations were compared. Fillet samples were analyzed for cesium-137 and other gamma-emitting radionuclides. Carcass samples were analyzed for strontium-90.

Cesium-137 results were below the analytical detection limit in all fish fillet samples collected and analyzed during 2002.

Strontium-90 was found in 13 of 15 carp carcass samples collected during 2002. The strontium-90 concentration in one of the five samples collected between 100-N and 100-D Areas was over six times greater than



Radionuclide levels were measured in ten California quail samples collected and analyzed in 2002. (Photograph by Kent Faris, PNNL.)

the median concentrations from all three sampling regions, and eight times greater than the highest value reported from the reference areas. This result (0.77 picocuries per gram) is the highest reported over the preceding 8-year period.

Liver samples from all bass and carp collected in 2002 were analyzed for heavy metals. Concentrations of most metals (antimony, beryllium, lead, nickel, silver, thallium, thorium, and uranium) were found to be near or below their analytical detection limits. The highest chromium concentrations were reported from bass samples collected at the upstream reference location. Copper and zinc concentrations in carp samples were generally 10 times higher than concentrations in bass samples.

California Quail

Radionuclide levels were measured in ten California quail samples collected and analyzed during 2002.

Cesium-137 was not detected in any of the six quail muscle samples from the 100-H and 100-F Areas nor in any of the four samples collected between the 100-D and 100-H Areas. There were no elevated concentrations of strontium-90 detected in the 2002 quail samples.



Deer are found across the Hanford Site. Nine deer samples were collected and analyzed during 2002.

Deer

Studies of mule deer populations residing on the central portions of the Hanford Site indicate they are divided into three relatively distinct groups; the north area population; the south area population; and the central area population.

Radionuclide levels were measured in nine deer collected on the Hanford Site during 2002. Cesium-137 was not detected in any of the nine deer muscle samples. These results are consistent with a decline in cesium-137 levels in all wildlife examined from 1983 through 1992 and with data obtained over the preceding 8 years.

Strontium-90 was detected in bone samples from all nine deer. Over the preceding 8-year period, the highest concentrations of strontium-90 were typically found in samples from the north area of the site. These higher concentrations may indicate some exposure to localized, low-level contamination near N Reactor.

Plutonium-238 and plutonium-239/240 were not found above their analytical detection limits in the one deer liver sample that was obtained during 2002 near the 200 Areas. These results are consistent with results reported throughout the 1990s.



Ground contamination surveys were conducted quarterly in 2002 along the Columbia River shoreline.



Thermoluminescent dosimeters are positioned 3.3 feet above the ground at 27 locations along the Columbia River. They measure exposure levels along the shoreline.

EXTERNAL RADIATION AND RADIOLOGICAL SURVEYS

External Radiation

External radiation also is surveyed on the Hanford Site. External radiation is defined as radiation originating from a source external to the body. External radiation consists of a natural component and a manmade component, which includes radionuclides generated for or from nuclear medicine, power, research, waste management, and consumer products containing nuclear materials (such as home smoke detectors).

Environmental radiation fields may be influenced by the presence of radionuclides deposited as worldwide fallout from atmospheric testing of nuclear weapons or those produced and released to the environment during the production or use of nuclear fuel. During 2002, environmental external radiation exposure was measured at the Hanford Site. Thermoluminescent dosimeters were positioned 3.3 feet above the ground at 33 Surface Environmental Surveillance Project locations on the site (this is an increase of four onsite locations compared to 2001), 11 locations around the perimeter of the site, 9 locations in surrounding communities including 2 at distant locations, and 27

locations along the shore of the Columbia River from Vernita Bridge to the mouth of the Yakima River.

Ground contamination surveys were conducted quarterly at 13 shoreline locations. These measurements were made to estimate radiation exposure levels attributed to sources on the Hanford Site, to estimate levels along the Hanford Reach shoreline, and to help assess exposure to onsite personnel and offsite populations.

Pressurized ionization chambers were situated at four community-operated monitoring stations. Real-time exposure rate data are displayed at each station to provide information to the public and to serve as an educational tool for the teachers who manage the stations.

The highest dose rate measured by Pacific Northwest National Laboratory onsite in 2002 was at the newly established location on the north side of the 300 Area (107 millirem). The maximum annual shoreline dose rate was 100 millirem per year measured at the 100-N shoreline, which was significantly lower than the maximum measured in 2001, but was not significantly lower than the 5-year maximum of 153 millirem per year measured during 1997. Over the past 5 years, the maximum dose rate along the 100-N Area shoreline has decreased as a result of cleanup efforts in the 100-N Area.



Technicians collect groundwater samples and prepare them for delivery to an analytical laboratory. The types of bottles used depend on the contaminants investigated.



Groundwater samples were analyzed for radionuclides, water quality parameters, metals and anions, and other contaminants such as pesticides and herbicides.

Radiological Surveys

Geiger counters and microrem meters were used to perform radiological surveys at selected Columbia River shoreline locations. The surveys showed that radiation levels at the selected locations were comparable to levels observed at the same locations in previous years. The highest dose rate was measured along the

100-N shoreline; the lowest dose rate was measured at the south end of the Vernita Bridge.

Exposure rates measured at four offsite locations with pressurized ionization chambers were between 7.3 and 8.8 microrentgens per hour near Hanford and 7.9 and 8.7 microrentgens per hour in Toppenish, Washington, a distant community location.

GROUNDWATER MONITORING

During 2002, samples were collected from 658 monitoring wells to determine the distribution and movement of existing radiological and chemical constituents in Hanford Site groundwater and identify and characterize potential and emerging groundwater contamination problems. Samples were analyzed for 25 radionuclides, 14 water quality parameters, 32 metals, 9 anions, and 12 other contaminants such as grease, pesticides or herbicides. To assess the quality of groundwater, measured sample concentrations were compared with EPA drinking water standards and DOE derived concentration guides.

The total area of groundwater contaminant plumes with concentrations exceeding drinking water standards was estimated to be ~76 square miles. This area oc-

cupies ~13% of the total area of Hanford. Most of the contaminated area lies southeast of the 200-East Area extending to the Columbia River. The most widespread contaminants within the plumes were tritium, iodine-129, nitrate, carbon tetrachloride, trichloroethene, chromium, strontium-90, technetium-99, and uranium.

Radioactive Contaminants

Tritium and iodine-129 are the most widespread radiological contaminants in groundwater associated with past site operations. Technetium-99 and uranium plumes are extensive in the 200 Areas and adjacent 600 Area. Strontium-90 plumes exhibit high concentrations in the 100 Areas, but are of relatively smaller extent. Strontium-90 also occurs in the 200 Areas and near the former Gable Mountain Pond in the 600 Area. Car-

bon-14 is present in two small plumes in the 100-K Area. Cesium-137, cobalt-60, and plutonium contamination occurs in isolated areas in the 200 Areas.

The highest **tritium** concentration measured at the Hanford Site in 2002 was 5.57 million picocuries per liter near the Plutonium-Uranium Extract Plant in the 200-East Area.

A maximum concentration of 4.23 million picocuries per liter was measured in a well located downgradient of the 618-11 burial ground, near Energy Northwest's leased land. Tritium levels site-wide are expected to decrease because of dispersion and radioactive decay.

No groundwater samples showed **iodine-129** concentrations above the DOE derived concentration guide in 2002. However, an iodine-129 plume at levels exceeding the drinking water standard is extensive in the 200 and 600 Areas. At the Hanford Site, the highest level of iodine-129 detected was 31.6 picocuries per liter near the TX and TY Tank Farms.

Technetium-99 was found at concentrations greater than the drinking water standard in the 200-East, 200-West, and 100-H Areas. The highest level measured in groundwater on the Hanford Site in 2002 was 99,700 picocuries per liter near the SX Tank Farm.

Total uranium has been detected at concentrations greater than the drinking water standard in portions of the 100, 200, and 300 Areas. The highest levels detected in groundwater at the Hanford Site during 2002 were in the 200-West Area near U Plant, where uranium levels were 2,110 micrograms per liter and exceeded the DOE derived concentration guide.

Strontium-90 concentrations greater than the drinking water standard were found in one or more wells in the 100 and 200 Areas. Levels of strontium-90 exceeded the DOE derived concentration guide in the 100-K and 100-N Areas. The 100-N Area had the widest distribution detected at the Hanford Site during 2002. The maximum concentration detected was 18,500 picocuries per liter in the 100-N Area.

Carbon-14 concentrations occur in wells at the 100-K Area and exceed the drinking water standard in two small plumes near the 100-KE and 100-KW Reactors. The maximum concentration in 2002 was 20,900 picocuries per liter near a former 100-KE Reactor waste disposal crib.

Cesium-137 was formerly detected in three wells located near an inactive injection well in the 200-East Area. However, these wells were not sampled in 2002. Cesium-137 appears to be restricted to the immediate vicinity of the former injection well.

Cobalt-60 was detected in wells in the northwestern part of the 200-East Area. The maximum concentration measured was 48.4 picocuries per liter at the BY cribs. This concentration was below the drinking water standard and the DOE derived concentration guide.

Plutonium was released to the soil column in the past at several locations in both the 200-West and 200-East Areas. The only location where plutonium isotopes have been detected in groundwater on the Hanford Site is near an inactive injection well in the 200-East Area. This well was not sampled during 2002.

Chemical Contaminants

Several non-radioactive chemicals regulated by EPA and Washington State are present in Hanford Site groundwater. These include carbon tetrachloride, chloroform, chromium, cyanide, fluoride, nitrate, tetrachloroethene, cis-1,2-dichloroethene, and trichloroethene. Of these chemicals, nitrate, chromium, and carbon tetrachloride are the most widely distributed in Hanford Site groundwater.

Nitrate is the most widespread chemical contaminant in Hanford groundwater because of its mobility and the large volumes of waste containing nitrate discharged to the ground. However, the areas affected by levels greater than the drinking standard are small.

In 2002, nitrate was measured at concentrations greater than the drinking water standard in portions of the 100, 200, 300, 600, and former 1100 Areas. The maximum nitrate concentration measured on the Hanford Site in 2002 was 2,090 milligrams per liter in the 200-West Area.

Chromium was detected above the drinking water standard in 2002 at the 100-D, 100-H, 100-K, and 100-N, 200-East, and 200-West Areas. The maximum detected concentration was 5,660 micrograms per liter in the 100-D Area. In the hexavalent form, chromium is very mobile in groundwater.



Groundwater monitoring relies on samples from wells across the site. A sampling vehicle and purgewater truck collect samples at a well near the Columbia River.

Groundwater pump-and-treat systems continued to operate in 2002 to reduce the amount of hexavalent chromium entering the Columbia River at the 100-D, 100-H, and 100-K Areas.

The purpose of the pump-and-treat systems is to prevent discharge of hexavalent chromium into the Columbia River at concentrations exceeding the EPA's standard for protection of freshwater aquatic life.

Carbon tetrachloride contamination occurs above the drinking water standard in much of the 200-West Area and represents one of the most significant contaminant plumes at the Hanford Site. The plume, which covers an area more than 4 square miles, extends past the 200-West Area boundary into the 600 Area.

Carbon tetrachloride has been found to have a high degree of mobility in groundwater. The highest concentration measured in 2002 was 6,900 micrograms per liter near the Plutonium Finishing Plant in the 200-West Area.

The highest **chloroform** concentrations were measured in a new well near the Plutonium Finishing Plant in the 200-West Area, where the maximum level was 680 micrograms per liter in January 2002. This concentration is above the drinking water standard.



Groundwater monitoring wells are sampled within the SX Tank Farm on the Hanford Site. The well is inside a subsurface vault.

During 2002, **trichloroethene** was detected at levels greater than the drinking water standard in several wells in the 100 and 200 Areas. The most widespread area of contamination occurred in the 200-West Area. The highest concentration measured in 2002 was 16 micrograms per liter in a well west of the TX and TY Tank Farms.

The highest levels of **cyanide** were detected in samples collected from wells in the northwestern part of the 200-East Area. The maximum concentration measured in 2002 was 299 micrograms per liter, which is above the 200-micrograms per liter drinking water standard.

Fluoride was detected above the primary drinking water standard near the T Tank Farm in the 200-West Area. The maximum fluoride concentration was 4.4 milligrams per liter on the east side of the T Tank Farm. A few other wells near the T Tank Farm showed concentrations above the secondary standard, which is based primarily on aesthetic rather than health considerations.

During 2002, **arsenic** exceeded the drinking water standard in three unfiltered groundwater samples from wells within the in situ redox manipulation zone in the 100-D Area.

VADOSE ZONE MONITORING AND CHARACTERIZATION

The vadose zone is defined as the area between the ground surface and the water table. The vadose zone functions as a transport pathway or storage area for water and other materials located between the soil surface and the groundwater aquifers.

Historically, the vadose zone at industrialized and waste disposal areas at the Hanford Site has been contaminated with large amounts of radioactive and non-radioactive materials through the intentional and unintentional discharge of liquid waste to the soil column, the burial of contaminated solid waste, and the airborne contaminants deposited on the ground. Depending on such factors as the makeup of the soil, the geology of the area, the nature of the waste, and the amount of water or other fluids available to mobilize the contaminant, contaminants can move downward and laterally through the soil column, can be chemically bound to soil particles (and immobilized), or can be contained by geologic formations.

Radioactive and hazardous waste in the soil column from past intentional liquid waste disposal, unplanned leaks, solid waste burial grounds, and underground tanks at the Hanford Site are potential sources of continuing and future vadose zone and groundwater contamination. Subsurface source characterization, vadose zone monitoring, soil-vapor monitoring, and vadose zone remediation were conducted in 2002 to better understand the distribution and mechanisms that control the movement of subsurface contamination.

VADOSE ZONE CHARACTERIZATION

During the year, vadose zone characterization activities were completed to evaluate the effectiveness of the remedial actions related to the CERCLA and to characterize existing vadose zone contaminant plumes to help plan future remedial actions.

Also during the year, several characterization efforts were performed at single-shell tank waste management areas. At Waste Management Area TX-TY in the 200-West Area, three new characterization boreholes were drilled and sampled to learn more about contaminant

distribution, particularly uranium, and contaminant transport mechanisms. A characterization borehole is a boring into the earth where sediment is collected and examined to address a specific question. In addition, the open borehole can then be used as an access way for instruments that can examine the sediment surrounding the borehole.

Vadose zone characterization was completed at five operable units in the 200 Areas to support remediation of sites that received waste from past-practice spent-fuel processing. The results of the characterization provide needed information to plan remedial activities in those areas. Characterization also was completed at one site in the 100-F Area to assess the effectiveness of remediation in the reactor areas.

The results of extensive geochemical characterization of core samples from Waste Management Area B-BX-BY in the 200-East Area became available during 2002. These data allow comparison of contaminated vadose zone sediment with uncontaminated sediment. In addition, the data are used to determine the leading edge of contaminant plumes beneath single-shell tanks in the waste management area. The same drill cores were used for several laboratory studies to determine geochemical characteristics of strontium and uranium in the vadose zone at Waste Management Area B-BX-BY.

Finally, characterization of the vadose zone at the location of the proposed Integrated Disposal Site in the 200-East Area continued during 2002.

VADOSE ZONE MONITORING

Vadose zone monitoring continued at the Hanford Site in 2002. Leachate and soil-gas were sampled and analyzed as part of monitoring of the Solid Waste Landfill and the Environmental Restoration Disposal Facility. Soil-gas monitoring continued at the carbon tetrachloride expedited-response site and geophysical borehole monitoring continued at single-shell tank farms to detect leaks and subsurface migration of contaminants. Borehole geophysical monitoring (or characterization) of drywells at past-practice liquid disposal

sites began during 2002. The first monitoring events at each site were designed to provide baseline results that will be compared to subsequent logging events to detect any subsurface contaminant movement.

A project was established during 2001 to monitor the movement of radioactive contaminants in the vadose zone using boreholes in single-shell tank farms. During 2002, 384 new logs were completed in wells and boreholes. A new geophysical logging detection system, the Radionuclide Assessment System, was used because it was simpler to use, faster than the previous systems, and more cost-effective for routine monitoring than other systems available at the Hanford Site.

The previous system, the Spectral Gamma Logging System, was used between 1995 and 2000 to establish a baseline record of existing radionuclide contamination in the vadose zone. Measurements using the new system can easily be compared to the baseline data acquired by the older system.

When routine monitoring by the new system identifies anomalies relative to the baseline, a more detailed examination of the anomaly may be required using the older system, which was designed specifically for such detailed work. A significant cost-savings is achieved by using the older systems only when necessary.

Geophysical logging of boreholes began at liquid waste disposal sites and solid waste burial grounds at the 200-East and 200-West Areas during 2001.

The purpose of this work is to determine concentrations of naturally occurring and manmade radionuclides in the vadose zone; this work is an extension of the baseline characterization work at single-shell tank farms. In addition, geophysical logging also was done to support remedial investigation projects and the RCRA Groundwater Monitoring Project.

The newly acquired data establish a baseline for future comparisons to determine contaminant mobility. Geophysical logging for vadose zone characterization was completed in 70 boreholes in 2002. Nine of these boreholes were new and were logged to support remedial investigation projects. Five boreholes were new RCRA groundwater monitoring wells and three new wells were drilled for the Integrated Disposal Site in the 200-East Area. Geophysical data from each borehole were analyzed to determine concentrations of naturally occurring radionuclides (potassium-40,

thorium-232, uranium-238, and associated decay products) and manmade radionuclides (e.g., cobalt-60, antimony-125, cesium-137, europium-152, europium-154, uranium-235, and uranium-238).

TECHNICAL STUDIES OF THE VADOSE ZONE

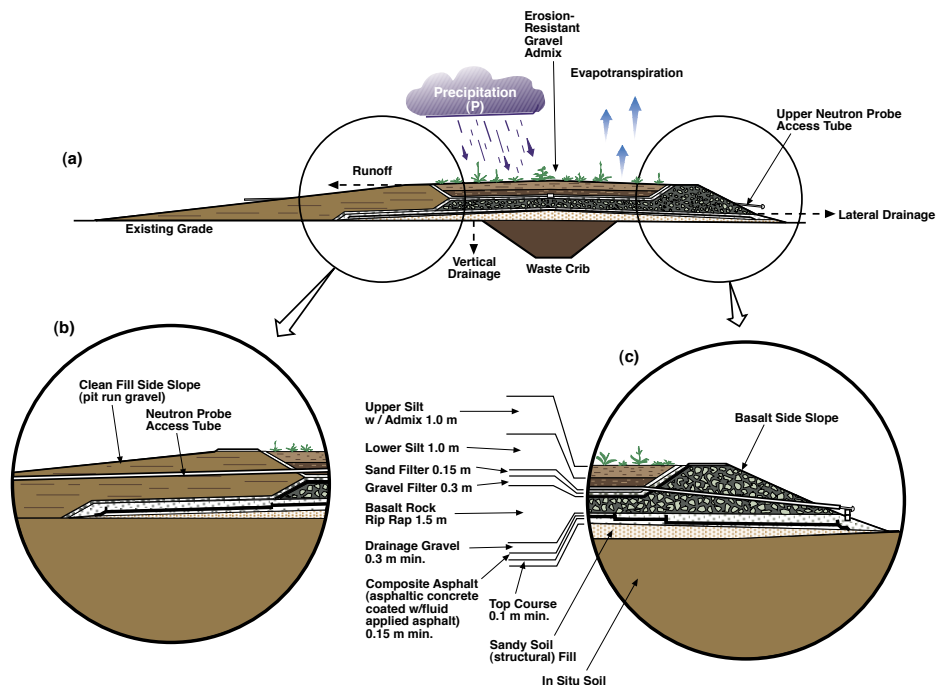
Several technical studies were carried out at the Hanford Site during 2002 to better understand the vadose zone sediment, hydrology, and contamination. These studies were designed to develop new, innovative methods for cleanup and monitoring at the Hanford Site.

Measuring Strontium-90. A borehole was drilled during 2001 to investigate Waste Management Area B-BX-BY and to collect samples for laboratory analysis to investigate subsurface contamination. Analyses from the samples showed high concentrations of strontium-90 that appeared to correlate with anomalous zones of gamma-ray activity, thus making the borehole a good place to test for bremsstrahlung radiation.

During 2002 a technique called spectral shape factor analysis was used to test this concept. The results of this test showed that there appears to be a spectral shape factor correlation between laboratory-measured strontium-90 concentrations and the gamma-ray count rate. This suggests that bremsstrahlung radiation may be the source of anomalous gamma-ray radioactivity observed in that borehole. The results of this investigation may lead to a method for quantitative measurement of strontium-90 in the subsurface.

Surface Barrier Tests. DOE has been investigating technologies that can be used to develop surface barriers at the Hanford Site.

A prototype surface barrier was constructed in 1994. It was designated to be used at waste sites in arid climates for at least 1,000 years. Because a barrier must last for at least 1,000 years without maintenance, natural construction materials (e.g., fine soil, sand, gravel, cobble, basalt riprap) and asphalt were selected for its design. Most of these are available in large quantities on the Hanford Site. The barrier consists of a fine-soil layer overlying other layers of coarser materials, such as sands, gravels, and basalt riprap. Asphalt provides an impermeable layer at the base of the barrier. Natural vegetation was then established on the surface of the barrier.



Cross Section of the Hanford Site Surface Barrier Showing (a) Interactive Water Balance Processes, (b) Gravel Side Slope, and (c) Basalt Riprap Side Slope.

The primary purpose of a surface barrier is to prevent water from passing through it. Infiltrating water (usually as precipitation) is the main driving force that will move waste downward to the groundwater. Therefore, it is important to know the water balance; that is, how much precipitation is diverted away and out of the soil cover by asphalt, how much water gets past the asphalt layer, how much water is surface runoff, how much water is stored in the soil, and how much water is lost by evapotranspiration.

To determine water balance, the north half of the prototype barrier was irrigated from November 1994 through October 1997 with water equivalent to three times the long-term average annual precipitation.

The results suggest that extreme winter precipitation, the prime cause of recharge and drainage of the vadose zone at the Hanford Site, is stored in the surface barrier until spring when it is removed from the soil by evapotranspiration.

Test results obtained to date show that in the site's arid climate, a well-designed barrier limits drainage to near-zero amounts. Data collected under extreme conditions (excess precipitation) provides confidence that the surface barrier has the capability to meet performance objectives for its 1,000-year design life.

Electromagnetic Induction and Ground-Penetrating Radar. The objective of this study was to investigate how electromagnetic induction and ground-penetrating radar responded to spatial and temporal variations in soil-water storage in a surface barrier. The study was conducted during 2002 on a prototype surface barrier. Electromagnetic induction measures the electrical conductivity of the ground; that is, it is a measure of the amount of electrical current that can move through the sediment. Water or moisture in sediment may dissolve substances that can make it easier for electric current to pass through the sediment, thus providing a method to determine the location of water or moisture and the amount present.

Non-invasive geophysical techniques offer significant advantages over traditional monitoring methods including high speed data acquisition, lower costs, high sampling resolution, and integration of multiple spatial scales. Furthermore, the non-intrusive nature minimizes damage to barrier integrity from instrument installation or degradation. The potential for the airborne deployment of electromagnetic induction and ground-penetrating radar make these methods attractive for monitoring large field-scale barriers.

Leak Detection Methods. From mid-July through early November 2002, Pacific Northwest National



In 2002, two electrical geophysical methods were evaluated at the 105-A mock tank facility in the 200-East Area of the Hanford Site.

Laboratory and CH2M HILL Hanford Group, Inc. evaluated two electrical geophysical methods at the 105-A mock tank facility in the 200-East Area. These two geophysical methods were designed to detect leaks beneath buried tanks. The techniques tested were electrical resistivity tomography designed by Lawrence Livermore National Laboratory and a high-resolution steel-casing resistivity technique designed by HydroGEOPHYSICS, Inc. The two techniques were initially tested during 2001 and were selected for further

QUALITY ASSURANCE

Quality assurance and quality control practices are incorporated into all aspects of the Hanford Site environmental monitoring and surveillance programs. Quality assurance programs are conducted to assure data quality.

They are implemented through plans designed to meet requirements of the American National Standards Institute/American Society of Mechanical Engineers and DOE Orders. Quality assurance plans are maintained for all activities, and auditors verify conformance.

Quality control methods include, but are not limited to, replicate sampling and analysis, analysis of field blanks and blind reference standards, participation in



Quality assurance and quality control practices are incorporated into all aspects of site environmental monitoring and surveillance programs.

evaluation during an appraisal/elimination process completed during January 2002.

Preliminary results indicate that the methods performed within the expected range of sensitivity for leak detection. Early indications from the high-resolution steel-casing resistivity technique suggested that equipment configurations in contact with the tank (as a receiver or transmitter) appear to be very sensitive to both leak detection and estimation of the leak volume.

interlaboratory cross-check studies, and splitting samples with other laboratories. Sample collection and laboratory analyses are conducted using documented and approved procedures. When sample results are received, they are screened for anomalous values by comparing them to recent results and historical data.

Quality assurance/quality control for environmental monitoring and surveillance programs also include procedures and protocols to document instrument calibrations; conduct program-specific activities in the field; maintain groundwater wells to assure representative samples were collected; and avoid cross-contamination by using dedicated well sampling pumps.



Staff from the Hanford Cultural Resources Laboratory document an historic farmstead to make way for the expansion of an adjacent gravel pit.

OTHER HANFORD ENVIRONMENTAL PROGRAMS

At the Hanford Site, a variety of environmental and cultural resource activities are performed to comply with laws and regulations, enhance environmental quality, and monitor the impact of environmental pollutants from site operations. Meteorological response is provided around the clock on the site in the event of a suspected or actual release of radioactive or hazardous material to the atmosphere. Comprehensive climatological data records are maintained to use in environmental impact assessment and dose reconstruction.

Scientists monitor the entire Hanford ecosystem and specific plant and animal species and habitats to assess the status of threatened, endangered, or commercially/recreationally important species and habitats and to identify impacts of Hanford Site operations on flora and fauna. Cultural resources on the site also are identified and evaluated to determine impacts from site operations. Historic buildings and structures are evaluated for their historic significance.



W.J. Kincaid managed the White Bluffs Bank, which was constructed in 1907 and incorporated in 1909. In the early 1900s, the bank was the only financial institution in the region.



The single-story bank was built of concrete blocks made from sand and river rock. It faces what used to be the main street of the town of White Bluffs.

CULTURAL RESOURCES

The DOE Richland Operations Office established a cultural resources program in 1987 that is managed by the Hanford Cultural Resources Laboratory. The Hanford Cultural Resources Laboratory has maintained a monitoring program since 1987.

The purpose of the program is to determine the impact of DOE policies on cultural resources and safeguard them from adverse effects associated with natural processes or unauthorized excavations and collections that violate federal laws.

Monitoring conducted during 2002 focused on Locke Island's erosion, archaeological sites with natural and visitor impacts, historic buildings and structures, and Native American sites.

Locke Island contains some of the best preserved evidence of prehistoric village sites existing in the Columbia Basin. It is included within the Locke Island National Register Archaeological District. It has sustained loss due to erosion along its eastern shoreline that has affected archaeological materials. Surveys in 2002 recorded erosional losses of up to 29.98 feet, as measured perpendicularly from the Columbia River.

Sixty-six archaeological sites were monitored across the Hanford Site in 2002 to gather data about the characteristics of each site, processes adversely affecting the site, and changes at the site.

Monitoring of historic buildings in 2002 focused on Bruggemann's Warehouse, the only cobblestone structure remaining on the Hanford Site, the First Bank of White Bluffs building, Coyote Rapids Hydroelectric Pumping Plant, Hanford Electrical Substation, and the Hanford town site high school. The buildings were photographed and locations of structural deterioration were identified.

Places with cemeteries or known human remains include locations that are sacred to the Wanapum, Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe. During 2002, all these places were monitored to document baseline conditions, determine whether wind or water erosion had exposed human remains, and assure that violations of federal laws were not occurring at these places. Overall, places with human remains were found to be stable during 2002. No violations were noted.



The Coyote Rapids Hydroelectric Pumping Plant was built in 1908 and operated until 1943. It is one of the historic structures being considered for preservation on the Hanford Site.

In summary, a total of 61 archaeological sites, 5 buildings, and a number of cemetery or burial locations were monitored during 2002. Of the findings recorded at these monitored places, most were related to natural causes such as animal trailing and digging, wind-caused erosion or aggradations, and water erosion. Some were also determined to be human-related, most of which were related to vehicle traffic where sites were exposed in roads or were located near fishing or duck hunting areas. One recorded finding was associated with recent collector digging within archaeological site boundaries and/or surface collection of artifacts.

Public discussions over the past several years focused on the ongoing curation of Manhattan Project and Cold War era artifacts into the Hanford collection. Public input was also sought on the draft *History of the Plutonium Production Facilities at the Hanford Site Historic District, 1943-1990*. DOE approved and published the book in June 2002.

During 2002, DOE continued to document the oral histories of early residents of areas now part of the Hanford Site as well as Native Americans, former Hanford Site workers, and current site employees. A total of eight interviews were conducted during 2002.



The Hanford High School is being considered for preservation. The two-story building was constructed using reinforced, poured-in-place concrete. The building was reportedly built in 1916 and operated until 1943.

CULTURAL RESOURCES REVIEWS

Pursuant to Section 106 of the *National Historic Preservation Act*, cultural resources reviews must be conducted before a federally funded, federally assisted, or federally licensed ground disturbance or building alteration/demolition project can take place. Because the Hanford Site is a federal facility, cultural resource reviews are required to identify properties within the proposed project area that may be eligible for, or listed in, the National Register of Historic Places and evaluate the project's potential to affect any such property.

During 2002, Hanford Site contractors requested 164 cultural resource reviews. A majority of the reviews involved areas that had been previously surveyed or were located on previously disturbed ground. Of the areas reviewed, 5 were monitored during the construction phase, 7 projects required an archaeological survey, and 33 involved proposed building modifications, demolitions, and Programmatic Agreement for the Built Environment exemptions. Exempt properties are those buildings and structures not clearly historic; therefore, they are not required to be evaluated for listing in the National Register of Historic Places due to their obvious lack of historical significance.



Hanford Site meteorologists provide weather forecasting to help manage weather-dependent operations and compile climatological data for environmental studies.



The Hanford Meteorology Station on the Central Plateau of the Hanford Site has collected data since it was established in 1944.

CLIMATE AND METEOROLOGY

The Hanford Meteorology Station is located on the Central Plateau between the 200-East and 200-West Areas of the Hanford Site. Operation of the station is managed by Pacific Northwest National Laboratory for DOE. Meteorological measurements are taken to support Hanford Site emergency preparedness and response, site operations, and atmospheric dispersion calculations for dose assessments. Hanford Site meteorologists provide weather forecasting to help manage weather-dependent operations and compile climatological data for environmental studies and to help assess the environmental effects of site operations.

Hourly observations at the station began on December 7, 1944, and have continued since that time. These hourly observations of wind direction, wind speed, and air temperature are made at multiple levels on the 408-foot tower near the station.

In addition, the Hanford Meteorological Monitoring Network consists of 30 remote monitoring stations. Most stations are on the Hanford Site; however, eight are offsite. All stations provide meteorological data every 15 minutes to a central computer located at the Hanford Meteorology Station.

Calendar year 2002 was slightly warmer than normal. The hottest day of the year was 113°F on July 13, and the coldest day of the year was 7°F on October 31.

The precipitation for 2002 totaled 5.41 inches (compared to normal 6.98 inches), and the snowfall totaled 2.8 inches (compared to normal 15.4 inches). December 2002 set a new record of any month for days with measurable precipitation – there were 21 days with ≥ 0.01 inch. December 2002 also established a new December record for days (5) with ≥ 0.25 inch of precipitation. However, there was a notable dry period between June 30 and November 6, 2002, when precipitation measured 0.29 inch.

The average wind speed during 2002 was 7.8 mph (compared to normal 7.6 mph). The peak wind gust during 2002 was 63 mph on December 27.

There were eight dust storms recorded at the Hanford Meteorology Station during 2002. There has been an average of five dust storms per year at the station during the entire period of record (1945-2002).

November 2002 established a new November record for persistent fog and dense fog.



Aerial surveys of spawning grounds of fall chinook salmon were performed during 2002. In 2002, 8,040 salmon spawning nests (redds) were observed in the Hanford Reach.



Canada goose nesting surveys began during the 1950s to document reproduction of the goose population and determine if nesting performance would demonstrate a response to nuclear reactor operations.

ECOSYSTEM MONITORING AND ECOLOGICAL COMPLIANCE

The Ecosystem Monitoring Project monitors the status of plant and animal populations on the Hanford Site, maintains biotic inventory data for the site, and assists in implementing ecosystem management policies. The status of rare plant populations and plant community types, spawning Columbia River fall chinook salmon, Canada geese, Asiatic clams, and bald eagles are monitored as part of the project.

FALL CHINOOK SALMON

In 2002, ~8,040 fall chinook salmon spawning nests (redds) were observed in aerial surveys of the Hanford Reach of the Columbia River, an increase of nearly 1,800 from 2001 and similar to the numbers seen during the late 1980s.

Aerial surveys do not yield absolute redd counts because visibility varies, depending on water depth and other factors, and because the number of redds in high-density locations cannot be counted accurately. However, redd survey data generally agree with adult numbers obtained by counting migrating adult fish at fish ladders on the Columbia River.

CANADA GEESE

Canada goose nesting surveys began during the 1950s to document the reproductive performance of the goose population and determine whether nesting performance would demonstrate a response to nuclear reactor operations. Continuous documentation of nesting performance has provided a way to evaluate the potential effects of legacy contamination from reactor operations, upstream industrial uses of Columbia River water, changes introduced by hydroelectric dam operations, and increased recreational use of the region.

During 2002, the nesting survey data and relevant contaminant information for this population were summarized.

Examination during 2002 of Canada goose nesting over the last 50 years reveals that the protection afforded the islands because of public exclusion from the Hanford Site has allowed geese to thrive. This trend is supported by the overall increases in numbers of nests and hatching rates.

Strontium-90 and heavy metal concentrations were analyzed in egg shells collected from Canada goose



Examination of Canada goose nesting over the last 50 years reveals that the protection afforded Columbia River islands because of public exclusion has allowed geese to thrive.

nests where at least one egg hatched. Analytical results show strontium-90 levels have continued to decrease since the late 1980s. Heavy metal concentrations were comparable to concentrations found at uncontaminated waterfowl and shorebirds sites, except for nickel.

Nickel concentrations appeared elevated with respect to other bird species at contaminated sites (maximum concentrations of 12.4 micrograms per gram in Hanford geese compared to 2.3 micrograms per gram in curlew near a metal smelter). Nickel has no known toxicological effects at these concentration levels. Birds appear to eliminate heavy metal by excretion and deposition in feathers and eggs.

BALD EAGLE

The bald eagle is listed as a federally threatened species and also a Washington State threatened species. Protection for bald eagles on the Hanford Site is guided by a management plan and coordinated with representatives of the U.S. Fish and Wildlife Service.

In accordance with the management plan, when the eagles are present, limited-access road closures within 875 yards, or within 437 yards out of line of sight of major perching, roost, and nesting sites have been mandated since 1994.



A number of bald eagles winter along the Hanford Reach of the Columbia River. No eagles have successfully nested along the Reach.

While road closures for perch and roost sites are effective from November 15 to March 15, nest tending activities by the bald eagles have extended the closure until August. During the closures, only emergency activity is permitted in buffer zones; low-impact activities (well monitoring) are considered on a case-by-case basis and are generally permitted out of the line of sight, but not closer than 437 yards from the nest site.

Since monitoring started in 1961, no bald eagles have successfully nested on the Hanford Site. Nesting attempts have been documented since 1997. Some factors that may result in nest abandonment include (1) adverse weather, (2) food availability, (3) human activity near the nest, and (4) avian predator interactions.

To evaluate the effect of human activities on nest abandonment and determine whether the present restrictions are adequate, data were collected on nesting behavior and on the eagles flush response.

Data on the flush response of bald eagles to the presence of vehicles or boats at various distances was collected from 1999 to 2001 and analyzed during 2002. The data indicate that vehicles are more likely to flush eagles than boats, and that 875 yards is probably an adequate distance to protect the bald eagles at Hanford from human-related disturbances.



Populations of persistent sepal yellowcress, occurring near the Columbia River, do not appear to have recovered after declining as a result of high river levels.



Piper's daisy is a species of concern on the Hanford Site. Surveys in 2002 indicated populations are increasing.

ASIATIC CLAMS

An assessment of contaminant concentrations in bivalves during 2001 demonstrated that Asiatic clams could be used as a monitoring species in the Columbia River to identify patterns of contaminant uptake. Because bivalves are relatively sedentary filter-feeders, they represent organisms with high potential for exposure to contaminants of concern along the near-shore environment when or if contaminants reach the river. Therefore, in 2002, ecological monitoring and contaminant surveillance of bivalves was initiated. Asiatic clams were collected during November 2002 to evaluate (1) demographics and distributions of the clam populations inhabiting Hanford shorelines, (2) bivalve tissue residue levels of three radionuclides and 16 metals, and (3) histology of target organs.

VEGETATION SURVEYS AND MONITORING

More than 100 rare plant populations of 31 different taxa are found on the Hanford Site. Five of these 31 taxa are species of concern in the Columbia Basin.

In addition to rare plant populations, several areas on the Hanford Site are designated as special habitat types with regard to potential occurrence of plant species of

concern listed by Washington State. They include areas that could support populations of rare annual forbs that have been documented in adjacent habitat.

Surveys in 2002 continued to indicate increases in the numbers of Piper's daisy, a species of concern. Populations of persistent sepal yellowcress, another species of concern occurring near the Columbia River, do not appear to have experienced significant recovery after declining as a result of the high Columbia River levels from 1995 through 2000.

Surveys of long-term monitoring plots within the footprint of the 2000 24 Command Wildland Fire show that total vegetation cover has not recovered to pre-fire levels and that a large amount of bare soil still persists in communities where big sagebrush was the dominant shrub. Decreases in total vegetative cover range from 12% to 79% for the nine vegetation cover types sampled.

Increased bare soil and lack of persistent native vegetation may offer increased opportunities for the establishment of invasive weeds. However, the overall frequency of occurrence of the common cheatgrass did not increase appreciably after the fire. In most communities, the frequency of cheatgrass decreased the year following the fire, but increased to near pre-fire levels during 2002.



DOE requires that all projects having the potential to adversely affect biological resources have an ecological compliance review performed before the project begins.

ECOLOGICAL COMPLIANCE

The policies of DOE's Richland Operations Office require that all projects having the potential to adversely affect biological resources have an ecological compliance review performed before the project begins. This review determines if the project will comply with the *Endangered Species Act* and the *Migratory Bird Treaty Act*.

Ecological compliance reviews also examine whether other significant resources such as Washington State listed species of concern, wetlands, and native shrub-steppe habitats are adequately considered during the project planning process. Where effects are identified, mitiga-



Ecological compliance reviews examine whether significant resources such as plant species of concern are adequately considered during project planning.

tion action is prescribed. Mitigation actions can include avoidance, minimization, rectification, or compensation.

Since many projects on the site occur during times of the year when plants are not growing, and the plants are difficult to identify or evaluate, each operational area is surveyed each spring. These baseline surveys provide information about habitat types and species inventories and abundance that can be used throughout the year to assess potential project impacts.

A total of 146 ecological compliance reviews were performed during 2002 in support of general Hanford activities. An additional 39 reviews were performed in support of environmental restoration activities.



Tribal staff and site contractors worked together during the completion of several field surveys on Locke Island.

STAKEHOLDER AND TRIBAL INVOLVEMENT

Many entities have a role in DOE's mission of environmental restoration, waste management, and protection of the Columbia River at the Hanford Site. Stakeholders include federal, state, and local regulatory agencies; environmental groups; regional communities and governments; and the public. Indian tribes and Nations also have a special and unique involvement with the Hanford Site and maintain a government-to-government relationship with DOE.

Several federal, state, and local regulatory agencies are responsible for monitoring and enforcing compliance with applicable environmental regulations at the site. Major agencies include the U.S. Environmental Protection Agency, Washington State Department of Ecology, Washington State Department of Health, and Benton County Clean Air Authority. The Hanford Natural Resource Trustee Council is another stakeholder. Local Indian tribes also are members of the council as well as the Washington State Department of Ecology, Washington Department of Fish and Wildlife, and the Oregon Department of Energy.

THE ROLE OF INDIAN TRIBES AND NATIONS

The Hanford Site is located on land ceded to the United States government by the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation in the Treaties of 1855.

These tribes, as well as the Nez Perce Tribe, have treaty fishing rights on portions of the Columbia River. These tribes reserved the right to fish at all usual and accustomed places and the privilege to hunt, gather roots and berries, and pasture horses and cattle on open and unclaimed land. The Wanapum are not a federally recognized tribe, but have historic ties to the Hanford Site as do the Confederated Tribes of the Colville Reservation, whose members are descendants of people who used the area now known as the Hanford Site.

The Hanford Site environment supports a number of Native American foods and medicines and contains sacred places important to tribal cultures. The tribes hope to safely use these resources in the future and want to assure themselves the Hanford environment is clean and healthy.

American Indian tribal governments have a special and unique legal and political relationship with the government of the United States, defined by history, treaties, statutes, court decisions, and the U.S. Constitution. In recognition of this relationship, the DOE and each tribe interact and consult directly.

Tribal government representatives from the Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe participate in DOE-supported groups such as the State and Tribal Government Working Group, the Hanford Natural Resources Trustee Council, the Hanford Site Groundwater/Vadose Zone Integration Project, the Hanford Cultural Resources Program, and provide review and comments on draft documents.

Both the Wanapum and the Confederated Tribes of the Colville Reservation are also provided an opportunity to comment on documents and participate in cultural resource management activities.

The DOE American Indian and Alaska Native Tribal Government Policy guides DOE's interactions with tribes for Hanford plans and activities. It states,

among other things, "The Department will consult with any American Indian or Alaska Native tribal government with regard to any property to which that tribe attaches religious or cultural importance which might be affected by a DOE action."

In addition to this policy, laws such as the *American Indian Religious Freedom Act*, the *Archaeological Resources Protection Act of 1979*, the *National Historic Preservation Act*, and the *Native American Graves Protection and Repatriation Act* require consultation with tribal governments. The combination of the Treaties of 1855, federal policy, executive orders, laws, regulations and the federal trust responsibility provide the basis for tribal participation in Hanford Site plans and activities.

Members of the Confederated Tribes of the Umatilla Indian Reservation, Yakama Nation, Nez Perce Tribe, and Wanapum were actively involved in the cultural resources program during 2002.

Each tribe was involved in deciding DOE's cultural resource program work scope, budget, and schedule. Monthly meetings on cultural resource issues provided a venue for the exchange of information between DOE, tribal staff members, and site contractors about projects and work on the Hanford Site.

During 2002, seven tribal meetings on cultural resources resulted in the exchange of information about projects and work on the Hanford Site.

These meetings included discussions of site-wide projects dealing with a wide range of topics. The topics included the impacts of a Bonneville Power Administration road maintenance project on Gable Mountain and a memorandum of agreement to mitigate the impact, archaeological excavation reports resulting from Section 106 projects, and development of alternative Section 106 procedures. Also discussed were 100-K Area remedial actions, stabilization characterizations of eroding sand dunes in the 100-F Area, and Fluor Hanford, Inc. pesticide programs. Meeting participants also looked at updates on the *Archaeological Resources Protection Act of 1979* violations, the draft archaeological programmatic agreement and the *Hanford Cultural Resources Management Plan*.



Locke Island, located in the Hanford Reach, contains some of the best preserved evidence of prehistoric village sites in the Columbia Basin.

Tribal staff and site contractors worked together during the completion of several field surveys to identify and record cultural features, sites, and landscapes in advance of new construction and archaeological test excavations and to monitor numerous projects requiring excavation during the year.

One member of the Wanapum assisted with cultural resource surveys, site form preparation, records management, and equipment use during 2002.

Interviews were conducted with Wanapum elders concerning traditional cultural properties on the site.

PUBLIC PARTICIPATION

Citizens of the state of Washington and neighboring states may influence Hanford Site cleanup decisions through public participation activities.

The public is provided opportunities to provide input and influence decisions through many forums, including Hanford Advisory Board meetings, Tri-Party Agreement activities, *National Environmental Policy Act* public meetings covering various environmental impact statements, and other involvement programs.



Tribal members recorded erosional losses along Locke Island's eastern shoreline.

The *Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan* outlines how public information and involvement activities are conducted for Tri-Party Agreement decisions.

To inform the public of upcoming opportunities for public participation, *The Hanford Update/Hanford Happenings*, a synopsis and calendar of all ongoing and upcoming Tri-Party Agreement public involvement activities, is published bimonthly and distributed to the entire mailing list.

To allow Hanford stakeholders and others to access up-to-date information, documents from the Tri-Party Agreement's Administrative Record and Public Information Repository are available on the Internet at <http://www2.hanford.gov/arpir>.

The public can obtain information about cleanup activities via a toll free telephone line (800-321-2008). Members of the public can request information about any public participation activity and receive a response by calling the Office of Intergovernmental, Public, and Institutional Affairs (DOE Richland Operations Office) at (509) 376-7501.

A calendar of public involvement opportunities can be found on the Internet at www.hanford.gov/calendar/.